EXHIBIT A

IN THE UNITED STATES DISTRICT COURT
DISTRICT OF PUERTO RICO

In re: THE FINANCIAL OVERSIGHT AND MANAGEMENT BOARD FOR PUERTO RICO, as representative of THE COMMONWEALTH OF PUERTO RICO, et al. **Debtors**[1]	**Case No. 17-BK-3283-LTS (Jointly Administered)**
In re: THE FINANCIAL OVERSIGHT AND MANAGEMENT BOARD FOR PUERTO RICO, as representative of PUERTO RICO ELECTRIC POWER AUTHORITY, **Debtor.**	**Case No. 17-BK-4780-LTS (Jointly Administered)**

EXPERT REBUTTAL REPORT OF

JURGEN WEISS, PH.D.

– MAY 15, 2023

[1] The Debtors in these Title III Cases, along with each Debtor's respective Title III case number and the last four (4) digits of each Debtor's federal tax identification number, as applicable, are the (i) Commonwealth of Puerto Rico (Bankruptcy Case No. 17-BK-3283-LTS) (Last Four Digits of Federal Tax ID: 3481); (ii) Puerto Rico Sales Tax Financing Corporation ("COFINA") (Bankruptcy Case No. 17-BK-3284-LTS) (Last Four Digits of Federal Tax ID: 8474); (iii) Puerto Rico Highways and Transportation Authority ("HTA") (Bankruptcy Case No. 17-BK-3567-LTS) (Last Four Digits of Federal Tax ID: 3808); (iv) Employees Retirement System of the Government of the Commonwealth of Puerto Rico ("ERS") (Bankruptcy Case No. 17-BK-3566-LTS) (Last Four Digits of Federal Tax ID: 9686); (v) Puerto Rico Electric Power Authority ("PREPA") (Bankruptcy Case No. 17- BK-4780-LTS) (Last Four Digits of Federal Tax ID: 3747); and (vi) Puerto Rico Public Buildings Authority ("PBA") (Bankruptcy Case No. 19- BK-5523-LTS) (Last Four Digits of Federal Tax ID: 3801) (Title III case numbers are listed as Bankruptcy Case numbers due to software limitations).

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I. INTRODUCTION AND BACKGROUND

1. I have been engaged by Proskauer Rose LLP ("Proskauer" or "Counsel") in its capacity as counsel for the Financial Oversight and Management Board for Puerto Rico (the "Oversight Board") in connection with the Confirmation Hearing for the Title III Plan of Adjustment of the Puerto Rico Electric Power Authority, or "PREPA" (as it may be amended, modified, or supplemented, the "Plan of Adjustment" or "Plan"). I submit this rebuttal report in response to the Expert Reports of Dr. Susan Tierney and Dr. Maureen Chakraborty, both dated April 28, 2023.

2. My name is Jürgen Weiss. I am currently an Academic Advisor to The Brattle Group, where I was a Principal until 2020, when I joined the senior faculty of the Harvard Business School for a two-year term as a Senior Lecturer. Most of my career was spent as an advisor on issues related to the transformation of the electricity sector, including and increasingly focusing on decarbonization and energy transition issues. I hold a PhD in Business Economics from Harvard University and an MBA from Columbia University. My full resume is attached as **Appendix 1**. The documents and data on which I relied in forming the opinions expressed in this report are identified in **Appendix 2**.

3. The Brattle Group is being paid $825 per hour for my services in this matter. Neither the firm's nor my remuneration is dependent on the outcome of this litigation.

4. In the event that additional documentation, data or explanations of existing data and documentation are provided that could affect my analysis, I reserve my rights to update my analysis and to revise my opinions as appropriate.

5. In this report, I rebut portions of the expert reports filed by Dr. Maureen Chakraborty and Dr. Susan Tierney. Specifically, I address Dr. Chakraborty's misapplication of the Oversight Board's affordability criteria, her use of a multi-decade inflation adjustment, which is inappropriate under the circumstances, and her manipulation of the Oversight Board's Revenue Envelope and Legacy Charge model to produce results that significantly overstate the revenues that are available to pay creditors. To this point, I demonstrate how Dr. Chakraborty changed the model input by using simplistic arithmetic to calculate unreasonably low monthly kWh

consumption that is not representative of the usage of median income permanent residential customers in Puerto Rico. I then show how Dr. Chakraborty utilizes this unreasonably low variable in the Oversight Board's model, erroneously alleging she is simply implementing the Board's methodology while correcting its "errors," without any consideration of calibration to basic parameters and elementary tenets of rate making, such as the resulting percentages of rate and bill increases.

6. With respect to the expert report of Dr. Susan Tierney, I show how Dr. Tierney significantly understated the growth of PV adoption in Puerto Rico by using inappropriate metrics and comparison geographies, ignoring important evidence and relying on arguments that are unsupported by evidence on the ground and contradict other conclusions that are included in her own report. The result is that Dr. Tierney understates the load moderating effects of PV and produces, on an overall basis, a high growth load forecast. More realistically, a plausible projection of PV could easily offset any arguably aggressive forecasts on energy efficiency measures mandated by current Puerto Rico law. This would serve to moderate Dr. Tierney's high load forecast considerably. Dr. Tierney also states that PREPA's capex requirements are overstated on the one hand, while, on the other hand, also suggesting that PREPA lacks sufficient funds and expertise to enhance its grid to accommodate growth in customer PV. In other words, she claims that not having enough capex is limiting the growth of PV in Puerto Rico while simultaneously claiming that PREPA's and Board's forecasts of PREPA capex forecasts are too high.

II. SUMMARY OF CONCLUSIONS

7. Dr. Chakraborty's insistence that the median electricity bill from the PRCS is representative of the monthly electricity usage of permanent median income households in Puerto Rico is misplaced and leads to inaccurate results. Review and analysis of the 11,147 responses from the households included in the PRCS data set indicates that lower electricity bills may be skewed by including survey responses from PREPA's subsidized rate classes (*e.g.*, RFR 105, 106 and 107) which provides a comparatively high level of monthly kWh usage for a low fixed bill (*e.g.*, a fixed $30 per month for up to 600 kWh per month). Removing certain outlier observations from

these classes moves the median value to $89 per month. Using $89 as a representative monthly electricity bill for a median income household in Puerto Rico and applying the appropriate blending of PREPA fiscal year 2021 yields electricity consumption of 427 kWh per month. This level of electricity usage is much more representative of monthly kWh consumption than is Dr. Chakraborty's low usage estimate, and is in line with estimation based on other available sources of information we used in our analysis.

8. Furthermore, Dr. Chakraborty's validation of her estimate of monthly electricity consumption using data from LUMA is also flawed. Dr. Chakraborty first calculates the median usage over all customers in each month, and then simply calculates the median of the monthly medians. In effect, this means she ultimately relies on the **average** of two monthly medians (i.e., the two middle months of all 12 months) and effectively disregards all of the information in the other months. This is a systematic flaw in her metric, which is biased downward as a result. Correct analysis of both the PRCS and the detailed LUMA customer data indicates that typical monthly kWh consumption for median income households permanently residing in Puerto Rico is much higher than Dr. Chakraborty's calculation of 369 kWh per month. In addition to the PRCS and LUMA data, we also considered aggregated LUMA data and kWh consumption associated with appliances as used in ranges of household sizes and regions compiled by the U.S. Energy Information Administration (EIA) to derive and validate our estimate of 425 kWh per month as representative of the monthly electricity consumption for a median income household in Puerto Rico.

9. Much of Dr. Chakraborty's conclusion that "PREPA can afford to pay substantially more than what is proposed to be paid under the Plan"[2] is based on her misunderstanding – or perhaps, misrepresentation – of the Oversight Board's affordability metric and methodology. The Oversight Board applied a percentage cap (6%) on spending for electricity by median income households as a maximum affordability threshold deliberately analyzed for the *first* year of implementation. This affordability threshold goes well beyond that used in other jurisdictions, which used 6% as an affordability threshold for *low income* customers. None of these

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[2] Chakraborty April 28, 2023 report, para 22

jurisdictions – or any other jurisdiction in the United States we are aware of – uses the 6% affordability threshold designed to apply to *half* of the population, which is the case in Puerto Rico. The Oversight Board's goal in designing the Revenue Envelope and Legacy Charges was not to place an even greater percentage of PREPA's customers at the "energy poverty" threshold for the duration of the Legacy Charge, which at a minimum is expected to be for 35 years.

10. Dr. Chakraborty is also mistaken in her alleged "correction" to apply a multi-decade inflation to Legacy Charge rates because, according to her, not doing so would not be "economically sensible."[3] Dr. Chakraborty's correction is to increase Legacy Charge rates annually so that Puerto Rico's median income households would pay 6% of their household income on PREPA electricity *ad infinitum*. As discussed above, an energy spending percentage threshold of 6% has been used as an indicator of energy poverty,[4] and as a threshold above which affected customers become eligible for financial support to ensure adequate access to essential energy services.[5] That is, a 6% home energy spend is **not** a sustainable target nor is it a relevant threshold for residential customers other than low-income customers. Dr. Chakraborty's proposal is clearly at odds with this.

11. Dr. Tierney's conclusion that the load forecast used by the Oversight Board in determining the revenue envelope and legacy charge revenues (i.e., the base case included in PREPA's 2022 Fiscal Plan) substantially underestimates future load is inaccurate because she applies an unrealistically pessimistic projection of PV penetration in Puerto Rico. Dr. Tierney increases the PREPA load forecast because, in her opinion, the PREPA forecast over-estimates energy efficiency projections, which has a downward impact on overall load. However, Dr. Tierney exacerbates her downward projections by concluding that PV penetration will be overly low in

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3 Chakraborty April 28, 2023 report, Para 13.

4 *See,* Brown, Marilyn A., et al. "High energy burden and low-income energy affordability: Conclusions from a literature review." Progress in Energy 2.4 (2020): 042003

5 Researchers have used a threshold of 6% of total household income to delineate consumers that experience high energy burdens for decades. Furthermore, several states in the U.S. provide financial assistance to consumers who spend 6% or more of their household income on energy bills. *See* Drehobl, Ariel, Lauren Ross, and Roxana Ayala. "How high are household energy burdens." An Assessment of National and Metropolitan Energy Burdens across the US (2020), and Washington State Department of Commerce. Low-Income Energy Assistance 2023 Legislative Report (March 6, 2023).

Puerto Rico. The result is an overly aggressive load forecast. A plausible projection of PV could easily offset any arguably aggressive forecasts on energy efficiency measures in compliance with Puerto Rico law, which would serve to moderate Dr. Tierney's high load forecast considerably.

12. Dr. Tierney's arguments that distributed solar PV adoption will be lower than estimated by the Oversight Board in the 2022 Fiscal Plan are based on her use of outdated modeling by NREL, which likely underestimates future distributed solar generation. She uses inappropriate metrics and comparison geographies, ignores important evidence and relies on arguments that are unsupported by evidence on the ground and contradict other conclusions that are included in her own report.

13. Notably, Dr. Tierney does not reference the active NREL and Puerto Rico study (among others) regarding the modeling and renewable energy outlooks for Puerto Rico through 2050. While this study (referred to as the "PR100" study) is still underway, preliminary findings released this year note that the "most pronounced finding is that *adoption of distributed solar and storage is projected to increase considerably in all scenarios*, with around 60% of residential customers adopting these technologies by 2050 in Scenario 1, which is a significant increase from current deployment."[6] This is in direct opposition to Dr. Tierney's claim that PREPA's 2022 Fiscal Plan unreliably overstates customer adoption, even though the Fiscal Plan assumes considerably less distributed solar adoption than the PR100 study.

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6 NREL, "PR100: One Year Progress Summary Report", January 2023, p. 8, https://www.nrel.gov/docs/fy23osti/85018.pdf. (emphasis in original)

III. AFFORDABILITY ANALYSIS

A. DR. CHAKRABORTY MISUNDERSTANDS THE OVERSIGHT BOARD'S CONSIDERATION OF AFFORDABILITY AS USED IN THE REVENUE ENVELOPE AND LEGACY CHARGE MODEL.

14. Dr. Chakraborty asserts that the "Board makes the unsupported assumption that the maximum affordable rates determined for the Hypothetical Residential Customer are also the maximum affordable rates for all residential non-exempt customers."[7] And later, in bold print, she asserts that "The Board Misapplies Its Own Share of Wallet Affordability Threshold."[8] Dr. Chakraborty then goes on to assert that the Oversight Board did not "directly assess the affordability or ability to pay for residential customers earning above the median income",[9] and claims that higher income customers can and should pay more for electricity. She "corrects" for this alleged analytic deficiency by lowering fixed charges and increasing volumetric charges so that higher income residential customers will pay more for their higher usage, which is loosely correlated with income.

15. Dr. Chakraborty misunderstands the Oversight Board methodology. The Oversight Board made no such assumption and made no such misapplication. In 2021, the percentage of income spent on electricity by a median income household in the U.S. is 2.1%,[10] while the comparable percentage in Puerto Rico is more than double. Under the Oversight Board's methodology in PREPA's Plan of Adjustment, recognizing that Puerto Ricans already pay a much higher share of their income for electricity, the Oversight Board applied a maximum percentage (6%) on spending for electricity by median income households as an affordability threshold only in the first year of implementation (i.e. FY 2024). *See* Exhibit P to the Disclosure Statement. The

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7 Chakraborty April 28, 2023 report, para 32

8 Chakraborty April 28, 2023 report, title of Section IV

9 Chakraborty April 28, 2023 report, para 41

10 This represents average US expenditures on electricity divided by median US income. The average monthly electricity bill in 2021 in the U.S. was $121.01 and median income was $70,784. Sources: U.S. Energy Information Administration EIA, (2021) "T5.a Residential average monthly bill by Census Division, and State", available at https://www.eia.gov/electricity/sales_revenue_price/pdf/table5_a.pdf and Kollar, J. S. and M. (2022, September 13). Income in the United States: 2021. Census.gov, https://www.census.gov/library/publications/2022/demo/p60-276.html.

Oversight Board's use of a 6% affordability threshold is stretching its application beyond its use in other jurisdictions. That is, 6% has been used as an affordability threshold for *low-income* customers in other jurisdictions.[11] However, in none of these jurisdictions or any other jurisdiction in the United States is the 6% affordability threshold designed to apply to half of the population. Here, the Oversight Board has extended the 6% threshold to *median income* households in Puerto Rico—which means that implementation of the revenue envelope and legacy charge analysis results in 50% of PREPA's residential customers spending 6% or more of their household incomes on electricity bills. Notably, however, the Oversight Board's goal in designing the revenue envelope and legacy charges was not to place an even greater percentage of PREPA's customers at the energy poverty threshold for the duration of the Legacy Charge, which at a minimum will be for 35 years. Placing such a high burden on a large portion of the population for so long has no precedent and does not conform to reasonable rate design. Indeed, the Oversight Board hopes that over time the 6% "share of wallet" will decline for the median income household customers, so that PREPA customers will receive some relief.

16. The rate design adjustments proposed by Dr. Chakraborty risk setting PREPA up for increased load defection, which the Oversight Board sought to avoid in specifying the Legacy Charge rate design. The rate design modification proposed by Dr. Chakraborty, under status quo circumstances, is designed to produce more Legacy Charge revenues by increasing the costs to residential customers who use above median volumes of electricity. However, sales levels will *not* remain at the status quo or close to the numbers calculated in the Dr. Chakraborty's report. Higher volumetric charges will result in higher costs that are nearly entirely avoidable by the target audience. That is, these higher income customers can avoid the higher volumetric charges by adding rooftop PV and batteries to their home energy portfolio, resulting in lower sales to

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[11] For example, Washington State uses a 6% threshold to identify household in need of energy assistance (Washington State Department of Commerce. "Low-Income Energy Assistance 2023 Legislative Report." 2023, available at https://deptofcommerce.app.box.com/s/qazu3yweu5w6udvnvw97qk5dwzop56p5) and New York State established an energy affordability target for the state of 6% in 2016 at established an energy affordability target for the state of 6% in 2016 (Understanding and Alleviating Energy Cost Burden in New York City, NYC Mayor's Office of Sustainability and the Mayor's Office for Economic Opportunity August 2019, available at https://www.nyc.gov/assets/sustainability/downloads/pdf/publications/EnergyCost.pdf.) Furthermore, 6% is a widely accepted high-energy burden threshold (see *i.e.,* Drehobl, A., Ross, L., & Ayala, R. (2020). How high are household energy burdens. An Assessment of National and Metropolitan Energy Burdens across the US.)

PREPA, an increasing deficit in PREPA's fixed cost recovery, and less Legacy Charge revenues available to pay creditors. This is exactly the scenario that the Oversight Board's design sought to avoid.

B. DR. CHAKRABORTY'S PROPOSAL FOR MULTI-DECADE INFLATION ADJUSTED LEGACY CHARGE RATES IS MISGUIDED.

17. Dr. Chakraborty claims that it is not "economically sensible" for the Oversight Board to apply the Legacy Charge rates (that it set based on analysis of 2024 circumstances) over the term of the Legacy Charge analysis.[12] Instead, Dr. Chakraborty asserts that the Oversight Board should increase the Legacy Charge rates **each year** so that creditors can be assured that the affected PREPA customers will be paying 6% of their household income *for thirty-five years or longer*.

18. Dr. Chakraborty appears to regard the Board's 6% affordability threshold as an aspirational goal or a targeted equilibrium condition. On the contrary, the 6% affordability threshold is based on energy spending caps that were specified by regulators and policymakers in U.S. states. Specifically, an energy spending percentage threshold of 6% has been used as an indicator of energy poverty,[13] and as a threshold above which affected customers become eligible for financial support to ensure adequate access to essential energy services.[14] That is, a 6% home energy spend is **not** an aspirational goal nor is it a relevant threshold for residential customers other than low-income customers.

19. As mentioned above, the Oversight Board's long term goal in setting the Revenue Envelope and Legacy Charge rates is to reduce the percentage of spending of median income households on electricity over time, not to hold it constant or to increase it. As shown below, the percent of

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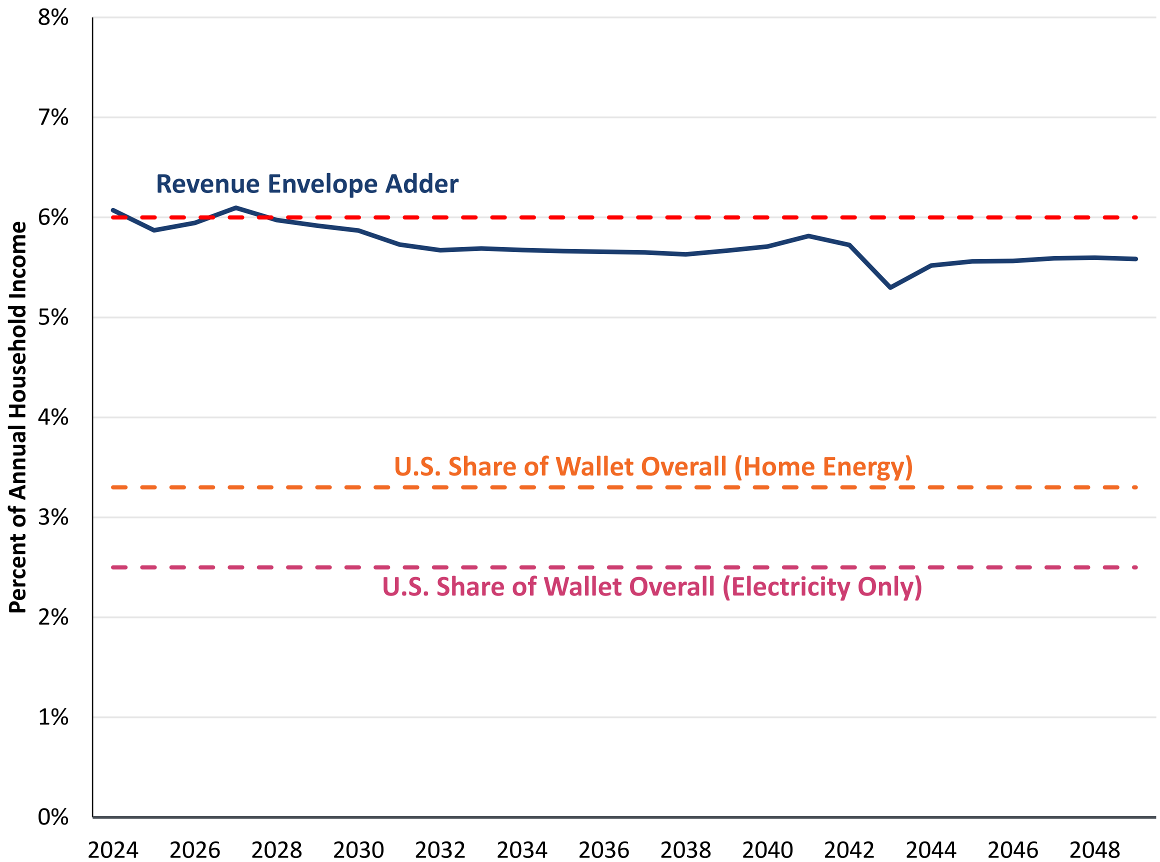
[12] Chakraborty April 28, 2023 report, Para 13.

[13] *See,* Brown, Marilyn A., et al. "High energy burden and low-income energy affordability: Conclusions from a literature review." Progress in Energy 2.4 (2020): 042003

[14] Researchers have used a threshold of 6% of total household income to delineate consumers that experience high energy burdens for decades. Furthermore, several states in the U.S. provide financial assistance to consumers who spend 6% or more of their household income on energy bills. *See* Drehobl, Ariel, Lauren Ross, and Roxana Ayala. "How high are household energy burdens." An Assessment of National and Metropolitan Energy Burdens across the US (2020), and Washington State Department of Commerce. Low-Income Energy Assistance 2023 Legislative Report (March 6, 2023).

spending by median income households on electricity under the rate increases included in the Plan of Adjustment is projected to decrease slightly over time and remain at high levels close to 6% through 2049.

FIGURE 1: PERCENT OF ANNUAL HOUSEHOLD INCOME SPENT ON ELECTRICITY



Notes:

(1) kWh consumption per median income household is projected to decline, following the per customer negative growth rates included in PREPA's 2022 Fiscal Plan gross load forecast less load loss from residential lighting based energy efficiency.

(2) Assumes household income grows at the rate of inflation forecast in the PREPA's 2022 Fiscal Plan, following (without accepting) assumptions included in Chakraborty April 23, 2023 report, para 57.

20. The "savings" gap between projected percent spending and 6% can easily be eliminated by even modest increases in PREPA's costs of operations beyond those anticipated in PREPA's 2022 Fiscal Plan. In addition to relieving some of the burden from PREPA's customers, a prudent

utility should have the ability to raise capital (and rates) to deal with unplanned expenditures. Remaining at the 6% threshold can therefore block access to needed capital when facing unanticipated expenditures.

21. The figure above also shows the approximate share of wallet for median income households in the United States for total home energy expenditures and for electricity only.[15] Home energy is a comprehensive measure that includes all energy sources used in the home, including oil and gas as well as electricity. In Puerto Rico, most if not all home energy comes from electricity. In 2021, the percent of median household income spent on home energy for the U.S. overall was 3.3% and the percent spent on electricity only was 2.5%. Benchmarked against either statistic, the electricity wallet share in Puerto Rico is currently considerably higher, and a 6% wallet share increases the gap still further. With the legacy charge, there is little chance that median income Puerto Ricans will see their share of energy spending even remotely approach the typical share of income experienced by US citizens on the mainland.

C. DR. CHAKRABORTY'S CLAIM THAT THE BOARD'S 6% AFFORDABILITY MEASURE IS UNRELIABLE IS MISINFORMED AND WRONG.

22. Dr. Chakraborty incorrectly characterizes this threshold as derived from New York studies, and makes the unsubstantiated argument that such a threshold should not apply to Puerto Rico households because shelter costs in Puerto Rico are much lower than those in New York.[16]

23. Dr. Chakraborty acknowledges, a household's housing cost is lower in Puerto Rico than in many places in the United States; however, relative to income levels, housing costs in Puerto Rico are

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[15] The U.S. Census does not provide information on both household median income and household expenditure, including home energy expenditures. I determined the percent household expenditure for median income households in the U.S. by (1) averaging the 5th and 6th deciles of household income for the median household income in the Census Bureau data set (the U.S. Census Bureau provides household income in "deciles," or 10% income bands, only in the income and expenditure data set) and 2) I divide the 5th and 6th decile average home energy and electricity expenditures by the 5th and 6th decile average household income to approximate the share of wallet for median income households in the U.S. Source: U.S. Bureau of Labor Statistics, Table 1110. Deciles of income before taxes: Shares of annual aggregate expenditures and sources of income, Consumer Expenditure Surveys, 2021.

[16] Footnote 8 and para. 59.

on par and in some instances more expensive than in the mainland US (including New York). For example, the U.S. Census Bureau reports that the 2017-2021 median gross rent in New York is $1,390, approximately 22% of the reported median income for the State ($75,157).[17] Dr. Chakraborty then concludes that PREPA customers are able to "spend somewhat more than 6% of income on electricity while still allowing Puerto Rico residents to remain well below 30% spending on total shelter costs."[18] The median income in Puerto Rico during 2017-2021 is reported to be $21,967,[19] while shelter costs in Puerto Rico, as reported by the U.S. Census Bureau, is $505 per month.[20] Thus, housing costs alone as measured by annual rent is equivalent to 28% of income in Puerto Rico, indicating that shelter cost is less affordable in Puerto Rico than it is in New York.[21]

24. Thus, Dr. Chakraborty's assertion that Puerto Rico households should be held to a higher affordability threshold than New York households, or elsewhere in the U.S., based on Puerto Rico's lower nominal housing costs is clearly incorrect.

IV. ELECTRICITY CONSUMPTION

25. Dr. Chakraborty's estimate of the monthly electricity usage for a median income household in Puerto Rico in 2021 and 2024 misrepresents the Board's methodology and is numerically wrong and unrealistically lower than the Board's conservative estimate of 425 kWh per month.

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17 Monthly rent of $1,390 is equivalent to $16,680 annually, approximately 22% of reported median annual income ($16,680/$75,157 = 22.2%). (Source https://www.census.gov/quickfacts/NY, accessed May 12, 2023).

18 Chakraborty April 28, 2023 report, Para 11, fn 8, and para 59.

19 Monthly rent of $505 is equivalent to $6,060 annually, approximately 28% of reported median annual income ($6,060/$21,967 = 27.6%).

20 United States Census Bureau, 2020 Census, https://www.census.gov/quickfacts/fact/table/PR/PST045222, accessed May 15, 2023.

21 Furthermore, in order to evaluate what is "affordable" for households in Puerto Rico, it is important to consider relative costs of basic needs other than shelter. Dr. Chakraborty fails to recognized that while housing costs are nominally lower in Puerto Rico, the costs for other necessities such as food are nominally higher: a 2015 report by Puerto Rico's Institute of Statistics found that supermarket items were 21% more expensive than in the US, and that overall, the cost of living was 13% higher than in 325 areas in the US. See Guardian News and Media. (2015, July 12). Puerto Rico's soaring cost of living, from giant electric bills to $5 cornflakes. The Guardian. https://www.theguardian.com/world/2015/jul/12/puerto-rico-cost-of-living.

26. Information identifying typical monthly electricity consumption (as measured in kWh) for median income households in Puerto Rico is not directly available from any data source we are aware of. This is because PREPA/LUMA, which has data concerning kWh consumption for each of its customers, does not have data concerning those customers' household income. Conversely, the Puerto Rico Consumer Survey (PRCS) has information about household income and electric bills, but not about electricity consumption or electric rates. Thus, at least two data sources – and likely more – are needed to develop a reasonable estimate of the typical monthly electricity consumption for a year-round median income customer in Puerto Rico.

27. We used four data sources to estimate the monthly electricity consumption for a typical median income household in Puerto Rico: 1) PREPA residential customer data aggregated by tariff and sub-class;[22] 2) the PRCS, which includes data on household income and monthly electricity bills (but not kWh usage); 3) the Energy Information Administration's (EIA's) Residential Energy Consumption Survey (RECS), which estimates electricity consumption associated with using appliances for a range of climate zones, building types, and income levels; and 4) monthly customer kWh usage data for each of PREPA's residential customers for a 24 month period (July 2020 through June 2022) provided by LUMA. As shown in Figure 1, each of these data sources results in somewhat different estimated levels of monthly electricity consumption by a median income household.

28. Dr. Chakraborty incorrectly claims that the Oversight Board used a single data source and posits that correcting alleged "mistakes" in using this single data source produces the "right" (and lower) number of monthly kWh consumption. Specifically, Dr. Chakraborty uses the 2021 PRCS and the blended electricity rates for 2021 provided in PREPA's 2022 Fiscal Plan to incorrectly calculate an unreasonably low level of consumption for a median income household in Puerto Rico. Her calculation of 369 kWh per month for a typical median income household in Puerto Rico in 2021, is (i) incorrect in itself, as she mistaken uses the wrong blending of PREPA's fiscal year 2021 and 2022 rates, (ii) inaccurate because it is based on an overly

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[22] Residential customers in rates RFR 105, 106 and 107; RH3 103 and 104; LRS 109 and 110; and GRS 111 and 112.

simplistic calculation of median values and (iii) incomplete because it is based on a single data source instead of considering other corroborating data sources.

29. The ranges of monthly kWh consumption estimated for a median income household in Puerto Rico from the data sources discussed above are summarized in the table below, and are discussed in greater detail in the sections that follow. As shown in the table, our initial estimate of monthly electricity consumption for typical median income customer in Puerto Rico (425 kWh per month) remains within the range of estimates for three of the four data sources, while the range of kWh consumptions in the EIA RECS data is higher than 425 kWh per month. These data, and more detailed discussion in the sections that follow, also demonstrate that Dr. Chakraborty's calculation is low and inaccurate.

FIGURE 2: SUMMARY OF MONTHLY KWH RANGE

Data Source	kWh Range
PREPA Residential Customer Data by tariff and sub-class	417 – 445
Puerto Rico Community Survey (PRCS)	427
EIA Residential Energy Consumption Survey (RECS)	430 – 446
Monthly Customer Level Data (LUMA)	390 – 436

A. AGGREGATE PREPA CUSTOMER DATA

30. Instead of relying exclusively on the 2021 PRCS, our initial estimate of typical monthly electricity consumption for a median income household in Puerto Rico was developed using data from LUMA (as operator of PREPA's T&D system) that provided aggregated monthly kWh usage over the 18-month period from June 2020 through December 2021 for nine classes of PREPA's residential customers: RFR 105, 106 and 107; RH3 103 and 104; LRS 109 and 110; and GRS 111 and 112. Customers in seven of these nine tariff classes receive service at rates less than the full cost of service (i.e., they receive subsidized electricity service), while customers served under GRS 111 and 112 receive non-subsidized electricity service.[23] Figure 2 below

[23] GRS111 customers receive a fuel subsidy for consumption up to 425kWh per month.

shows the number of customers, as reported by LUMA, in each tariff class and our estimate of the associated average monthly kWh consumption for each class.

FIGURE 3: CALCULATION OF MONTHLY ELECTRICITY CONSUMPTION FROM AGGREGATED PREPA CUSTOMER DATA

	Customers with Non-zero Consumption June 2021 [A]	Annual Load Fiscal Year (kWh) [B]	Avg Per Customer (kWh) [C]
Subsidised			
RH3 103	6,841	21,141,522	258
RH3 104	3,926	11,145,599	237
LRS 109	119,632	492,007,828	343
LRS 110	181,629	722,239,019	331
RFR 105	6,841	26,935,745	328
RFR 106	31,631	224,256,146	591
RFR 107	3,431	35,356,415	859
Total	353,931	1,533,082,274	361
Un-Subsidised			
GRS 111	195,720	770,156,588	328
GRS 112	884,430	5,352,185,239	504
Total	1,080,150	6,122,341,827	472
Total	1,434,081	7,655,424,102	445
Midpoint of Subsidised and Un-Subsidised			417

31. The table also shows our initial estimate of the typical monthly electricity consumption for a median income household, which we estimated to be between a midpoint of 417 kWh to and a weighted average of 445 kWh.

B. PUERTO RICO COMMUNITY SURVEY

32. The 2021 PRCS, based on a questionnaire answered by a sample of residents in Puerto Rico. The 2021 PRCS contains electricity bills for 11,147 households,[24] was only the second data source we considered Among many other responses, the survey provides data on household income and monthly electricity bills (but not kWh consumption). Our initial estimate of monthly electricity usage for a median income household from the PRCS was derived by: (i) identifying the median electricity bill, (ii) dividing the bill (in dollars) by the per kWh rate charged by PREPA at the time, and (iii) associating this kWh estimate with median income households. Based on issues raised in Dr. Chakraborty's April 28, 2023 report, we examined the PRCS data in greater detail to ensure that these data are appropriately used, and we found that Dr. Chakraborty's calculation of median electricity bills using the PRCS was flawed and led to inaccurate results.

33. First, Dr. Chakraborty made a computational error in "correcting" the kWh consumption calculation associated with PRCS data. Monthly kWh consumption is calculated by dividing the monthly electricity bill (in dollars) by the rate per kWh charged by PREPA for the subject period. Dr. Chakraborty criticized our initial calculation as being inaccurate because we did not account for the difference between PREPA rates (which are provided on a fiscal year basis) and the PRCS electricity bills (which are gathered over the course of a calendar year). However, Dr. Chakraborty's claimed correction itself is also flawed. Assuming that survey responses were collected uniformly over the entire calendar year, this means that 1/12 of survey responses were collected in January 2021. However, in January 2021, the last monthly electricity bill any customer would have received would not be the bill from January 2021 (since the month hadn't ended), but, depending on the survey date and the date at which customers receive their bills, most likely either the bill from December or November 2020. The same would be true for any survey conducted in later months, that is, the last electricity bill would be from a month at least one, and potentially two (or more) months prior. In calculating the monthly kWh in the table

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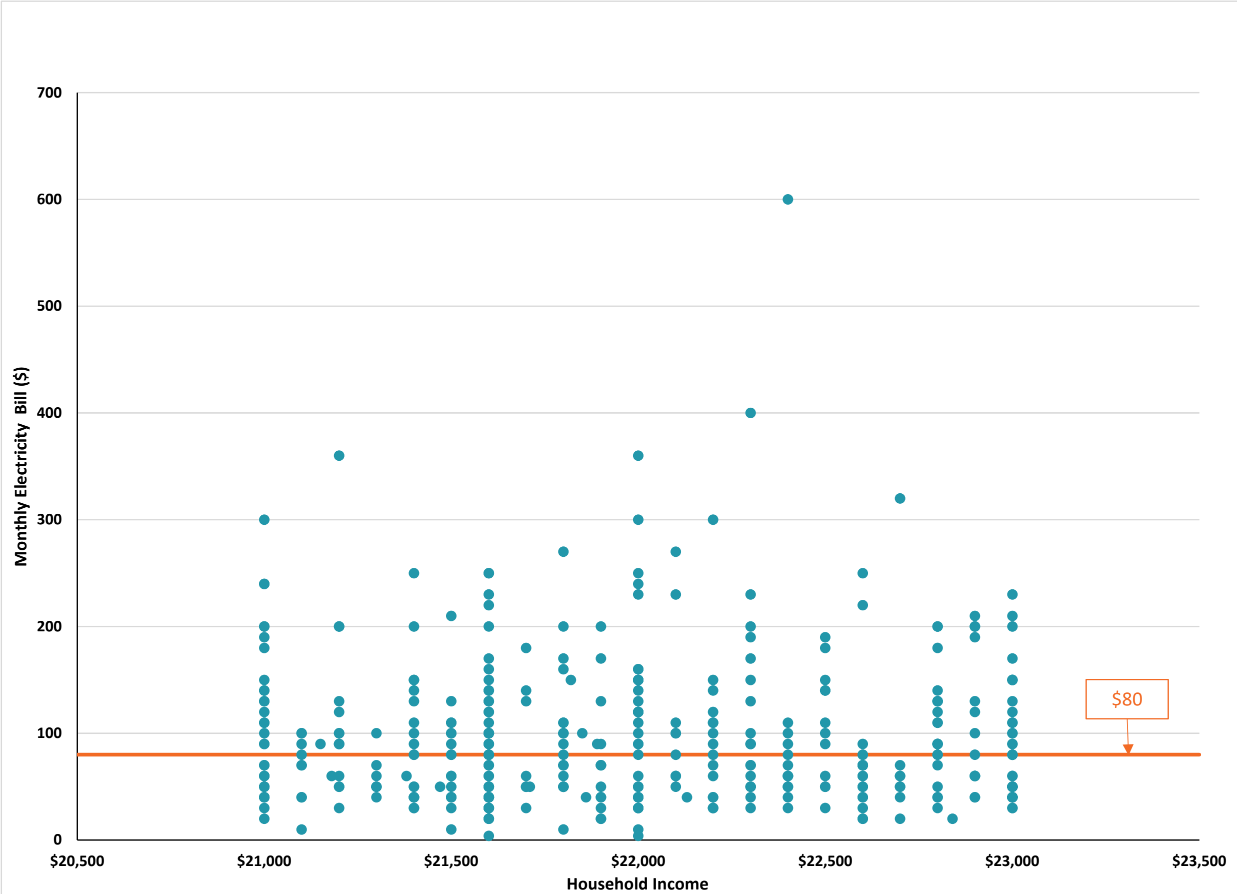
[24] The total number of households and institutions in the 2021 PRCS is 12,211. We excluded observations for which electricity bills were coded as 0, 9993, and 9997, meaning that the electricity bills were coded as not applicable, no charge or electricity used, and/or electricity included in rent or condo fee. *See* https://usa.ipums.org/usa-action/variables/COSTELEC#codes_section.

above, we assume a one-and-a-half month lag, yielding implied weights to be applied to the Fiscal Plan rates for 2021 of 7.5/12 and 2022 of 4.5/12. We apply the same weights to the Fiscal Plan rates for FY 2021 and FY 2022 of 7.5/12 and 4.5/12, respectively. This "corrected" approach by itself results in estimated electricity consumption of 382 kWh per month instead of the 369 kWh per month calculated by Dr. Chakraborty.

34. More importantly, however, Dr. Chakraborty's use of the PRCS data to calculate the kWh consumed by a representative median income household in Puerto Rico is flawed and leads to inaccurate results. The PRCS data provide information on respondent household income, electric bills and various electricity-consuming devices present at respondent's household. However, it does not provide information about the respondent's monthly kWh consumption, nor does it provide information about the rate or rate class under which the respondent receives electric service. Blind application of a simplistic approach – such as simply finding the median in a large dataset – can, and in the case of Dr. Chakraborty's analysis, almost certainly does, lead to biased results. A more thorough analysis of the PRCS data results in a materially different result.

35. Our initial analysis indicated that the median electricity bill for all 11,147 households in the 2021 PRCS survey is $80 per month. The median captures the middle value of a set of numbers arranged in order of magnitude. Household electricity bills in the survey sample range from $4 to $600 per month, with a standard deviation of $87 per month – which is larger in magnitude than the median observation ($80 per month)! A closer examination of the reported electricity bills for median income households (i.e., 2021 median income, approximately $22,000, +/- $1,000) shows a wide dispersion, as shown in Figure 3 below.

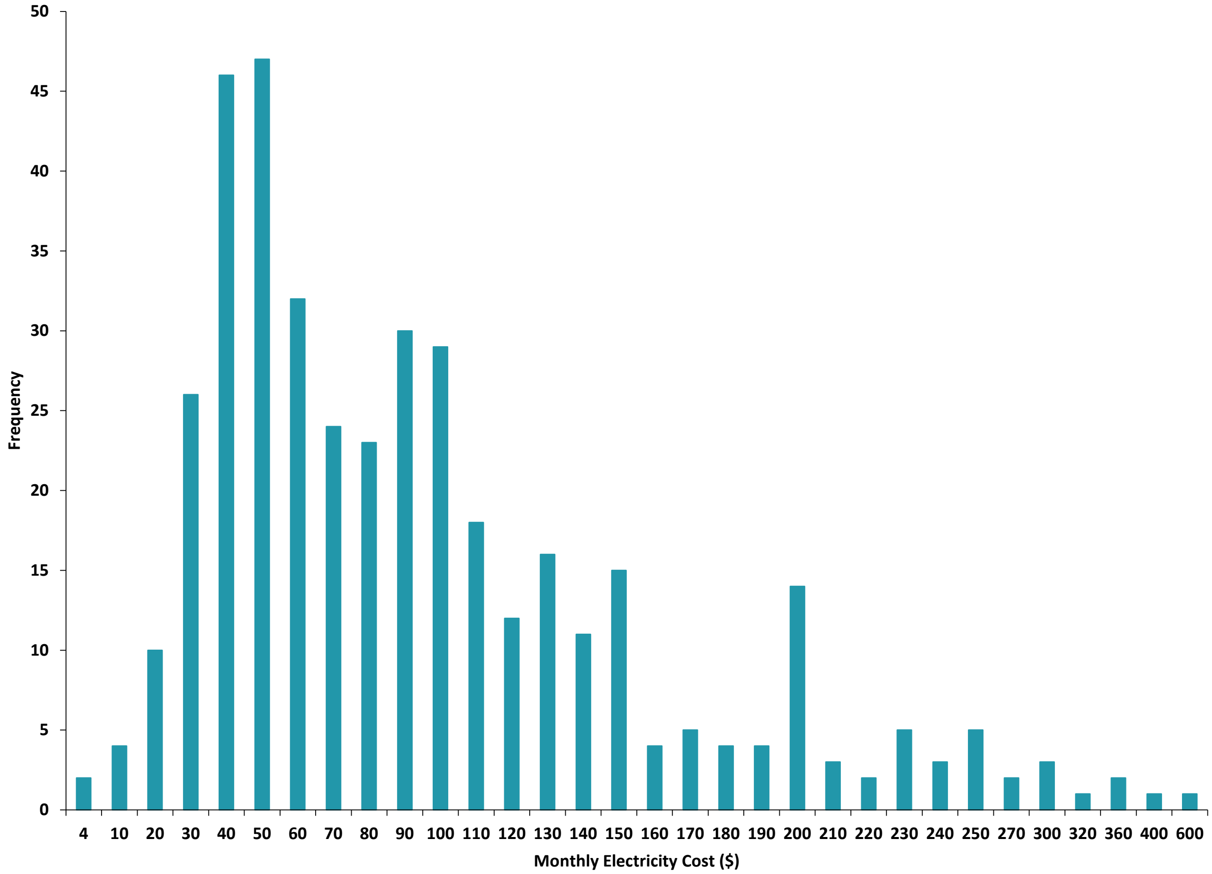
FIGURE 4: 2021 PRCS DATA ANALYSIS – MONTHLY ELECTRICITY BILLS FOR HOUSEHOLDS WITH INCOME: $21,000 TO $23,000



36. The scatter plot of observation in the figure indicates that there is little correlation between reported household income and reported electricity bill. Instead, there is a huge variation in monthly bills independent of income, and a large variation of income for almost any given level of monthly electric bills. Second, there are many observations with electricity bills that are very low, which is at odds with PRCS survey responses which indicate that respondent households have major appliances, such as refrigerators, which use 50 or more kWh per month by themselves. This means that selecting the median of the entire dataset by no means guarantees that the median energy bill has anything to do with the median-income household, and strongly suggests that the median electricity bill will not be representative of electricity usage for a median income household, even when we limit the data set to only median income households.

37. Examination of the distribution of household electricity bills, as shown below, also revealed that monthly electricity bills are skewed to the left due to a high percentage of observations that are $30, $40 and $50 per month.

FIGURE 5: 2021 PRCS DATA ANALYSIS – DISTRIBUTION OF MONTHLY ELECTRICITY BILL FOR HOUSEHOLDS WITH INCOME: $21,000 TO $23,000



38. These reported bills of $30, $40 and $50 per month match the bills received under PREPA's fixed bill tariff RFR, available for customers residing in public housing under ownership of the public housing administration. Specifically, the rates from PREPA are: $30 per month as a fixed fee for up to 600 kWh per month (for a one room housing unit); $40 per month as a fixed fee for up to 800 kWh per month (for two or three room housing); and $50 per month as a fixed fee for up to 1,000 kWh per month (for four or five room housing).[25] There are 119 households (out of

[25] PREPA tariff for Residential Fixed Rate For Public Housing under Ownership of the Public Housing Authority (RFR).

the 404 in the sample) that report electricity bills of these amounts. Full information about the status of these respondents (*i.e.*, whether they receive electricity service from PREP under the RFR or not) is not available, however removing a small portion of these observations from the data sample changes the median value materially. Specifically, removing 20% of the $30, $40 and $50 per month electricity bill observations moves the median value to roughly $89 per month – which is the same value as the sample's average after removing outlier values (*i.e.*, the highest and lowest 5% of electricity bills included in the sample).

39. Using $89 as a representative monthly electricity bill for a median income household in Puerto Rico and applying the appropriate blending of PREPA fiscal year 2021 and 2022 rates, as discussed earlier, yields electricity consumption of 427 kWh per month.

C. ENERGY INFORMATION ADMINISTRATION RECS

40. The third data source we considered in determining the typical monthly electricity consumption for a median income household in Puerto Rico was the US EIA's Residential Energy Consumption Survey. [26] The RECS provides data with respect to the electricity used to power a wide range of appliances, from lighting to space air conditioning and heating. The PRCS proved helpful in specifying a portfolio of appliances for a household in Puerto Rico; it indicated that *all* households in the sample responded that they had a refrigerator in their home. Furthermore, basic appliances include lighting and water heating as staples for a full time (and even part time) resident.

41. The RECS also provides such data for different sizes of housing, by climate zone and for income segments. We used the RECS to determine monthly electricity usage for a representative median income household equipped with basic electric appliances. These include a (single) refrigerator,

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26 The Residential Energy Consumption Survey (RECS) is administered to a nationally representative sample of housing units. Interviewers collect energy characteristics on the housing unit, usage patterns, and household demographics. This information is combined with data from energy suppliers to these homes to estimate energy costs and usage for heating, cooling, appliances and other end uses. Data was sourced from the 2015 RECS Release, tables CE5.3a and CE5.3b at https://www.eia.gov/consumption/residential/data/2015/index.php?view=consumption.

a (single) television, basic lighting, an electric stove for cooking, a water heater, a clothes washer (but not a clothes dryer) and a single ceiling fan. The appliance portfolio that we examined <u>excludes</u> a dishwasher, a microwave, a dehumidifier and, perhaps most notably, air conditioning.

42. The figure below shows the usage for each appliance as well as total monthly electric usage for representative households in the South Atlantic region, for hot and humid climates, for a two- and four-member household and for a single family detached houses.

FIGURE 6: PORTFOLIO OF APPLIANCE ELECTRICITY USAGE – ENERGY INFORMATION ADMINISTRATION RECS

	South Atlantic	Hot-humid Climate	2 Member Household	4 Member Household	Single family detached
Ceiling fans	28	30	24	27	27
Water heating	254	227	222	407	281
Clothes washers	5	5	5	6	5
Lighting	102	94	91	116	110
Most-used refrigerators	50	51	50	51	53
Cooking	19	19	20	25	23
Most-used TVs	21	20	20	20	20
Monthly Consumption	478	446	430	652	519

43. As shown in the table, monthly electricity consumption is lowest for smaller households (i.e., 2-member household) and higher for larger sized households (i.e., single family detached and a 4-member household). We use a range of 430 to 446 kWh as a range that is applicable for this analysis.

D. MONTHLY CUSTOMER KWH CONSUMPTION DATA

44. The fourth data source we considered was a detailed data set of the monthly metered electricity consumption for PREPA's residential customer for the 24-month period spanning July 2020 through June 2022. Review of these data present a range of data reliability issues, which have been confirmed in conversation with LUMA. The most obvious data aberration involves zero

monthly consumption values, which most likely are caused by broken meters, a problem which LUMA acknowledges. In addition, extremely low consumption readings (such as single digit kWh usage) are not reconcilable with regular use of electricity, suggesting metering and/or customer information system deficiencies. Also, we identified significant data reporting errors for two months in the data set (April and May of 2022), with which LUMA agreed were problematic. We now understand that there may have been problems with the data for the months of January through April 2022, as well.

45. As a result, LUMA provided updated customer usage data to replace the prior data we had been given for the 12 months from July 2021 through June 2022.[27] We merged the updated LUMA customer data for this period with the data LUMA produced previously for the prior 12 months, to form a panel of data over all of the residential customers reported in the data over the 24-month period from July 2020 through June 2022. We noted that using the updated LUMA data for the latter 12 months in this period did not materially change the results of our analysis to determine the typical electricity consumption of PREPA's unsubsidized residential customers in rate classes GRS 111 and 112.

46. The subject data set includes over 33 million single observations, including 27 million for PREPA's unsubsidized customers served under GRS 111 and 112. Similar to Dr. Chakraborty's analysis,[28] we first excluded observations for which kWh consumption was reported to be zero. Furthermore, we used information from the 2021 PRCS and the EIA RECS to determine our treatment of low usage observations. The PRCS indicated that all households in the sample responded that they had a refrigerator in their home, a staple (along with basic lighting) for a full time (and even part time) resident. As shown earlier, the EIA's RECS shows that a single refrigerator alone uses roughly 50 kWh per month and lighting by itself consumes nearly 100 kWh per month for most households, with households earning less than $20,000 per year using roughly 60 kWh per month for lighting. We report results for median kWh consumption for

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[27] We received the updated LUMA data for this 12-month period on May 12, 2023, only days before submitting this report. Therefore, while the results reported here are based on the updated data, we are also continuing to analyze the data. This data has also been produced to the creditors.

[28] Chakraborty Report, para 51 and Exhibit 9.

permanent median income residents in Puerto Rico by excluding from our analysis (i) customer observations that reported less than 50 kWh per month, as a single refrigerator uses this level of electricity monthly and (ii) customer observations that reported less than 100 kWh per month, as a combination of a refrigerator and basic lighting consumers this level of electricity per month.

47. Removing missing data (*i.e.*, zeros) from the data set results in a median of 397 kWh per month for customers served under GRS 112. Excluding customers that use less than 50 and more than 3,600 kWh[29] per month increases the observed median for customers served under GRS 112 to 423 kWh and excluding observations for customers that use less than 100 kWh per month increases the median to 463 kWh. The median usage for customers served under GRS 111 is lower. However, this tariff class is available only to customers who are designated as elderly, students and/or disabled.[30]

48. The results of our analysis of PREPA's monthly customer kWh consumption data is summarized in the figure below.

[29] The data also includes high monthly meter readings. These could represent very large single-family residential dwellings, but also multi-unit dwellings with a single electric meter. Since it is impossible to identify whether a meter is connected to a single or multiple residential units, it is prudent to exclude observations above a certain level as very likely multi-unit dwellings.

[30] These customers are eligible to receive a fuel cost subsidy under PREPA Rider FOS (Fuel Oil Subsidy), which results in lower overall electricity rates for the first 425 kWh of electricity used each month. See General Residential Service tariff, Reconciliation Clauses and Riders, Rider FOS – Fuel Oil Subsidy.

FIGURE 7: ANALYSIS OF PREPA MONTHLY RESIDENTIAL CUSTOMER DATA – GRS 111 AND 112

Exclusions	Rate Class	Number of Customers	kWh / Month Median	kWh / Month Mean
Raw Data	111/112	1,009,382	339	446
	112	810,462	368	478
Excluding Customers with Missing Observations	111/112	921,040	365	476
	112	739,265	397	510
Excluding Customers with Monthly kWh < 50 & kWh > 3,600	111/112	829,961	390	487
	112	667,078	423	519
Excluding Customers with Monthly kWh < 100 & kWh > 3,600	111/112	729,868	433	531
	112	593,482	463	562

49. The methodology that we employ to complete the above analysis of the detailed LUMA dataset is in sharp contrast to the flawed methodology employed by Dr. Chakraborty, who uses her analysis of the LUMA data to support her unreliable estimation of median electricity consumption using the PRCS.

50. The first problem with Dr. Chakraborty's analysis is that her measure of monthly kWh usage is a poor measure of what the median-income residential customer in Puerto Rico consumes in a typical month. This is because she uses a methodology that does not actually track a typical customer's electricity usage over time as we do, using the LUMA customer data. Instead, she calculates a monthly kWh usage number that is artificially low by design.

51. Rather than calculating the median electricity usage for each customer in the LUMA data over the 24 months of data LUMA produced, Dr. Chakraborty calculates the median usage over all customers in each month. She then relies on the median of those monthly medians over all 24 months. Since the median is simply the middle observation in a series (or the average of the two middle observations if there is an even number of observations), Dr. Chakraborty's metric in any given month reflects the actual electricity usage of only one, or at most, two PREPA customers in that month. Likewise, her metric reflects the usage of only one or two likely different

customers in the following month, and so on. After doing this for each month, she then simply calculates the median of the monthly medians. In effect, this means she ultimately relies on the average of two monthly medians (i.e., the two middle months of all 24 months) and effectively disregards all of the information in the other months.[31] By picking the median of monthly medians, her calculated provides some (limited) information about how consumption is spread over the course of the year, but says nothing about the typical annual usage of a single customer, whose consumption she claims to be estimating. This is a systematic flaw in her metric. It simply reflects the median usage in the middle two months of a two-year period over all customers, not a typical customer's usage over all 24 months.

52. This fundamental error in Dr. Chakraborty's metric means that she ignores the information value inherent in the LUMA customer data. The key value of having customer-level data is the ability to track each customer's usage from month to month to calculate each customer's typical usage over time, as we do. Our approach accounts for seasonal variation in a customer's usage, and it is why we calculate each customer's consumption over a trailing 12-month period to actually measure their typical usage over the course of a year.[32] Her metric is overly simplistic. Her approach includes countless individual observations that are above zero but clearly not reconcilable with a permanently occupied residence and therefore does not measure the typical usage of a PREPA customer over all months of a year, is systematically downward biased, and is unreliable.

[31] Dr. Chakraborty presents her result as a straightforward use of a simple median metric. The fact that the median she calculates is actually an arithmetic average of the median values from two months is one small example of how her approach and description are overly simplistic.

[32] In order to estimate the median customer's electricity consumption, we start by deriving annual electricity consumption to account for seasonality. We sum the monthly electricity consumption over a 12-month period for customers that have non-missing observations for each month in the period. Then, we derive a single monthly observation per customer from their annual consumption. We repeat this process for each trailing 12-month period.

V. HIGH-LEVEL CONCLUSION

53. Dr. Chakraborty's expert report mechanically applies a set of modifications to what she erroneously claims to be the Board's methodology to the Revenue Envelope and Legacy Charge model and fails to consider whether her "corrected" results are either plausible or robust.

54. Dr. Chakraborty fails to address the plausibility of both her "corrected" inputs – such as an estimated monthly kWh consumption incompatible with other sources of information – or outputs, such as resulting rate or bill increases. By failing to examine the plausibility of her inputs and outputs, she mechanically calculates an alternative "revenue envelope" not only at odds, rather than in line with the Board's methodology, but also far outside the plausible. Dr. Chakraborty increased the revenue envelope fixed charge from $21 to $31, for a total fixed customer charge of $35 per month – making PREPA's fixed customer charge among the highest in the country and providing additional incentive for some PREPA customers to completely disconnect from the grid (i.e., *grid* defection, in contrast to the load defection that is modeled by price elasticity of demand). Dr. Chakraborty's further extended her rate adjustment to incremental volumetric rates, increasing the rate that would be paid by residential customers from $0.0075 per kWh to $0.01267 per kWh for the first 500 kWh consumed each month, and from $0.03 per kWh to 0.05068 per kWh for usage above 500 kWh per month. This amounts to a nearly 50% increase in the fixed charge for residential customers relative to the Oversight Board's proposed $21, and a nearly 70% increase for each of the incremental volumetric kWh usage blocks. Dr. Chakraborty similarly increases the fixed charges and volumetric rates applied to PREPA's commercial, government and industrial customers. The increases in volumetric rates would push further load defection, as these charges are avoidable and provide customers incentives to pursue substitutes, such as PV and batteries.

55. The Oversight Board adopted a Revenue Envelope and Legacy Charge structure which pushed bills to PREPA residential customers to high levels by any yard stick. However, the Oversight Board's threshold for feasible high bill increases is *de minimis* when compared to the bill increases Dr. Chakraborty suggests are feasible and affordable. The table below shows the percentage increase in bills for representative residential, commercial and industrial customers under the Oversight Board's proposed revenue envelope rate structure compared to the increases

in bills for these customers under Dr. Chakraborty's proposed rate structure, only one of the potential sources of additional revenues in Dr. Chakraborty's Table 1.[33]

TABLE 1: PERCENTAGE BILL INCREASES UNDER REVENUE ENVELOPE CHARGES

	FOMB		Chakraborty	
	2024	2045	2024	2045
Residential (GRS 112, 425 kWh)	24.9%	17.1%	37.5%	25.8%
Residential (GRS 112, 600 kWh)	20.2%	13.9%	30.9%	21.3%
Commercial (GSS 211, 1,600 kWh)	16.8%	11.3%	27.0%	18.2%
Industrial (GSP 312, 40,000 kWh)	22.5%	14.5%	35.4%	22.9%

56. Dr. Chakraborty consistently assumes the Board's intention and methodology without basis, misapplies her incorrect assumptions without considering relevant facts or data issues, and comes to conclusions that fail a basic test of plausibility and reasonableness. She does so by portraying the task of estimating the amount of legacy debt that is both affordable and feasible as a simple arithmetic exercise when it is not. Dr. Chakraborty fails to provide an implementable approach to determine a feasible proposal.

VI. PREPA LOAD FORECAST

A. DR. TIERNEY'S ARGUMENTS RELY ON OUTDATED AND SELECTED MODELING FROM NREL, WHICH UNDERESTIMATES FUTURE DISTRIBUTED SOLAR PV CAPACITY

57. Dr. Tierney cites Mid-Case Scenario projections from the National Renewable Energy Laboratory ("NREL")[34] to support her assertion that rooftop solar adoption on Puerto Rico cannot reasonably be estimated to proceed at the speed assumed in the PREPA 2022 Fiscal Plan load projection. Specifically, Dr. Tierney claims that:

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[33] Chakraborty Report, Table 1, following para 2.

[34] NREL Data Viewer, "Mid-Case Scenario," State and Local Planning for Energy, 2020, https://maps.nrel.gov/slope/data-viewer?layer=standard-scenarios.mid-re-cost&res=state&year=2020&filters=%5B%5D.

> "The result of making these aggressive and unsupported assumptions about residential solar adoption is that PREPA's Base Case and Alternative Forecast both assume much greater growth of distributed generation than is reasonable to expect in Puerto Rico, or even in states with much more experience and governmental funding to support distributed generation adoption. **Figure 8** compares PREPA's Base Case and Alternative Forecast of distributed solar generation to NREL's mid-case scenario forecasts for U.S. states with the highest levels of predicted load reduction from distributed solar generation between 2020 and 2050. Each of these states have higher median household incomes than Puerto Rico. Although my experience leads me to expect that Puerto Rico's pace of solar adoption should be slower than these states, PREPA's forecasts predict that Puerto Rico pace of adoption will, by 2037, surpass even these leading states—and, indeed, all states in the contiguous U.S. That is unrealistic and unsupported."[35]

58. Dr. Tierney's Figure 8 uses highly selective data inappropriately and is based on assumptions that cannot be justified or, at a minimum, need to be seen in a broader context. Specifically, it relies on NREL projections, which, given the Department of Energy's own assessment of the accuracy of its own projections, may be underestimating solar PV development. Her distributed solar PV projections in Figure 8 are based on a 2020 model even though a 2022 version was available at the time Dr. Tierney filed her report and the 2022 version of the Mid-case Scenario highlights the likely bias in the NREL forecasting methodology. Also, her Figure 8 uses a metric, share of gross load, which relies on data not in the Mid-Case Scenario and also is not the (only) relevant metric to compare the Board's distributed solar generation forecast. Finally, it compares the Board's projections to NREL's forecasts for select other states that are not an appropriate comparison. Growth rates, annual distributed PV installations recently achieved, or absolute cumulatively installed capacity for states of similar size or at similar stages of development with

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[35] Expert Report of Susan Tierney ("Tierney Report"), ¶61 and fn 61.

respect to solar PV provide more relevant information. I will describe each of these issues in more detail below.

1. The NREL Forecast is not reliable for this purpose.

59. Forecasting the growth of new and potentially disruptive technologies is challenging. Solar PV including rooftop solar PV represent new and potentially disruptive technologies. The most prominent forecasts about the evolving US energy system are made by the US Energy Information Administration ("EIA") in its Annual Energy Outlook ("AEO"), which projects various elements of the US energy system through 2050. In a recent self-evaluation, the EIA has found that it has been systematically under-projecting the growth of solar PV in the United States.[36] While NREL forecasts are not the same as those included in the AEO, there are overlaps in the overall modeling infrastructure used by the government. For example, the NREL Mid-Case Scenario uses electricity demand growth and gas price assumptions from the AEO (2020).[37]

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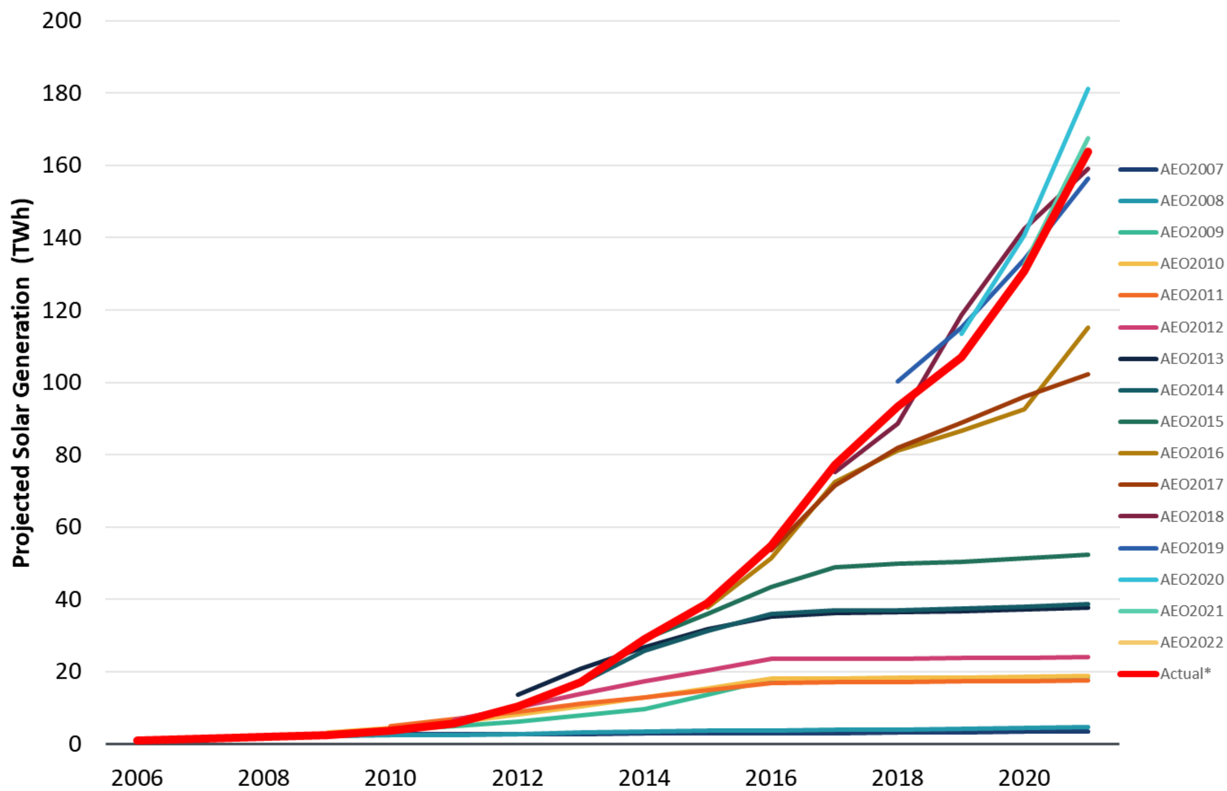
36 EIA, Annual Energy Outlook 2022 Retrospective: Evaluation of Previous Reference Case Projections, September 2022, pp. 3-4. *See also*, EIA, Wind and Solar Data and Projections from the U.S. Energy Information Administration: Past Performance and Ongoing Enhancements, March 2016, p. 1.

37 *See* https://maps.nrel.gov/slope/data-viewer?layer=standard-scenarios.mid-re-cost&res=state&year=2050&filters=%5B%5D.

FIGURE 8: AEO FORECASTS OF NET SOLAR GENERATION



Notes: Based on EIA, Annual Energy Outlook 2022 Retrospective: Evaluation of Previous Reference Case Projections, p. 46, September 2022

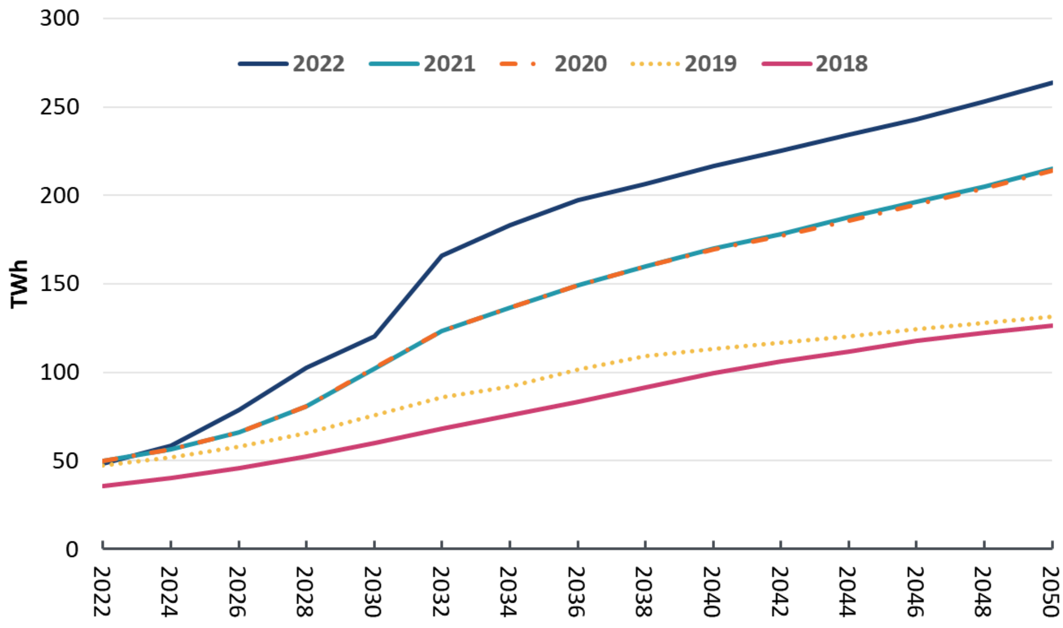
60. Figure 8 shows the systematic bias in the EIA's solar projections, repeatedly and incorrectly projecting solar generation to grow slowly from current levels, when reality (indicated by the thick red line) shows a very different and much more exponential growth path. The US government is not alone at not being very good at forecasting the evolution of solar power, including distributed solar power; the International Energy Agency ("IEA") has also been criticized for its under-estimation of solar adoption in its annual World Energy Outlook ("WEO").[38]

[38] PV Magazine, "IEA low-balls solar growth (again)", 9 October 2018, https://www.pv-magazine.com/2018/10/09/iea-low-balls-solar-growth-again/.

61. While the EIA analysis covers all solar generation and not just distributed solar PV, and while it assesses the projections in the AEO rather than the NREL projections used in Dr. Tierney's analysis, there is reason to believe that NREL's projections of distributed solar PV suffer from a similar bias, as evidenced by the change in forecast levels for successive versions of NREL's Standard Scenarios.

Figure 9 below shows how the projections of distributed solar generation for the contiguous U.S. have changed over recent years.[39]

FIGURE 9: NREL DISTRIBUTED SOLAR PV PROJECTIONS



Source: NREL 2018-2022 Standard Scenarios, Mid-Case.

[39] NREL 2022 predicts 84 GW of additional distributed solar capacity between 2022 and 2032. In comparison, SEIA/WoodMac expect over 95 GW of residential PV additions, with another 1.5-2 MW/year of commercial PV additions implying over 110 MW of additional distributed solar capacity over 10 years. *See*, SEIA, "Solar Market Insight Report 2022 Year in Review", 9 Mar 2023, https://www.seia.org/research-resources/solar-market-insight-report-2022-year-review.

63. As the figure shows, NREL's projections for distributed solar PV adoption have increased significantly over the past few years. Even since 2020, the outdated model version relied on by Dr. Tierney, NREL's US-wide forecast has increased by 17% for 2030 and over 20% for 2050. This relationship is also observed for states Dr. Tierney selected to include in her analysis. For instance, the 2022 NREL Mid-Case projects 22% higher distributed PV generation in California by 2050 than the 2020 NREL and 27% higher generation in Massachusetts. Dr. Tierney's Figure 8 unreasonably understates the potential distributed solar adoption based on her selection of an older, outdated NREL model and one that likely suffers from a more general under-estimation bias similar to the AEO's solar PV forecasts, given the similar patterns in Figure 8 and Figure 9 above, with consecutive forecasts seemingly following real world developments by correcting past-under-forecasts, only to repeat the under-forecasting error in future projections.

64. Furthermore, Dr. Tierney selects one scenario, the Mid-case Scenario, from a host of scenarios produced by NREL. NREL (like AEO) models its Mid-Case based on current laws and existing policies already in place, with no new policies assumed.[40] Consequently, if the approach underlying the Mid-Case Scenario were used to model the Puerto Rico energy system, such a forecast would assume the Puerto Rico Energy Policy Act ("Act 17") and its energy efficiency goals would be met, but not the impacts of the Inflation Reduction Act ("IRA"). NREL produces scenarios, which, unlike the Mid-Case Scenario used by Dr. Tierney, include modeling the impact of the IRA or assume lower cost solar PV, 100% renewable electricity targets, and others. Given that the IRA was law by the time Dr. Tierney filed her report, these other scenarios are potentially more relevant than the Mid-case Scenario. Dr. Tierney fails to explain why the 2020 Mid-Case Scenario should be used for the comparison rather than more recent scenarios.

65. In fact, Dr. Tierney fails to consider NREL modeling focusing specifically on Puerto Rico. The NREL Standard Scenarios model the contiguous US, therefore leaving out Hawaii, Alaska, and

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[40] Gagnon, Pieter, Maxwell Brown, Dan Steinberg, Patrick Brown, Sarah Awara, Vincent Carag, Stuart Cohen, Wesley Cole, Jonathan Ho, Sarah Inskeep, Nate Lee, Trieu Mai, Matthew Mowers, Caitlin Murphy, and Brian Sergi. 2022. *2022 Standard Scenarios Report: A U.S. Electricity Sector Outlook*. Golden, CO: National Renewable Energy Laboratory, p. 3 NREL/TP-6A40-84327. https://www.nrel.gov/docs/fy23osti/84327.pdf.

territories like Puerto Rico. Yet NREL, along with multiple other stakeholders,[41] have been working with Puerto Rico to evaluate how to best meet commitments established under Act 17, namely 100% renewable energy by 2050. NREL refers to this modeling effort as Puerto Rico Grid Resilience and Transitions to 100% Renewable Energy Study or "PR100". While this study is still underway, preliminary results from its one-year progress summary indicate that significant growth in distributed solar is expected in Puerto Rico by 2050:[42]

> All scenarios rely on a significant increase in rooftop solar photovoltaics (PV) and associated battery energy storage systems. Preliminary modeling shows that Scenario 1 requires a 6x increase in distributed solar and storage systems between 2022 and 2050, while Scenario 4 shows a 16x increase. This "maximum" scenario would be achieved by increasing the current rate of deployment by approximately 4x. Across all scenarios, distributed PV capacity would range from 3 GW to 7 GW.
>
> *****
>
> Our most pronounced finding is that *adoption of distributed solar and storage is projected to increase considerably in all scenarios*, with around 60% of residential customers adopting these technologies by 2050 in Scenario 1, which is a significant increase from current deployment.

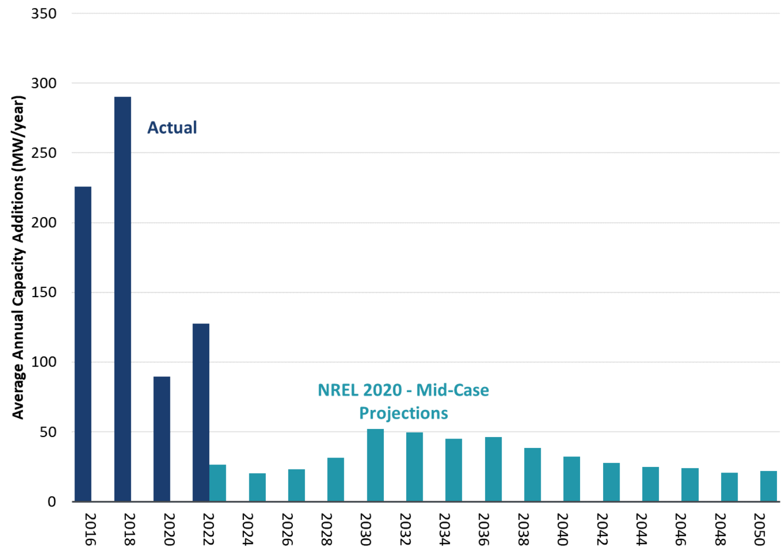
66. While the choice of scenario or study matters, NREL's distributed solar forecasting methodology under its Standard Scenarios (for the contiguous US states) more generally results in projections

41 Stakeholders include the Department of Energy, Federal Energy Management Agency, Sandia National Laboratory, Pacific Northwest National Laboratory, Lawrence Berkeley National Lab, Argonne National Laboratory, Oak Ridge National Laboratory, Colorado State University, PREPA, LUMA Energy, Puerto Rico Energy Bureau, and the Puerto Rico Department of Housing. *See*, https://www.energy.gov/gdo/puerto-rico-grid-resilience-and-transitions-100-renewable-energy-study-pr100 and NREL, "PR100: One Year Progress Summary Report", January 2023, https://www.nrel.gov/docs/fy23osti/85018.pdf.

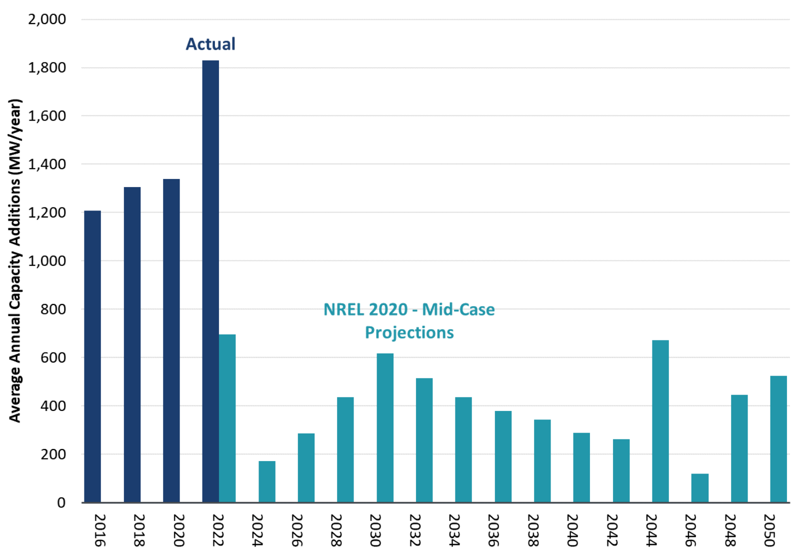
42 NREL, "PR100: One Year Progress Summary Report", January 2023, pp. 4, 8, https://www.nrel.gov/docs/fy23osti/85018.pdf. (emphasis in original)

that appear unreliable. For example, EIA data on historical (actual) distributed PV installations indicate that Massachusetts added about 125 MW per year of distributed PV capacity between 2020 and 2022 (two years). Yet the NREL 2020 data used by Dr. Tierney expected only 27 MW per year would be added during that time frame and that, going forward, Massachusetts would only install between 20-50 MW per year. These projections are far below the historical levels of distributed solar installations recently observed. In fact, NREL's under-estimation for 2022 means that its forecast takes until 2030 to produce the same amount of installations that were *already experienced* between 2020 and 2022. Figure 10 (Panels A and B) below shows the NREL projections and actuals for both Massachusetts and California, two of the states Dr. Tierney uses in comparing the PREPA Fiscal Plan projections to NREL projections.

FIGURE 10: DISTRIBUTED PV ANNUAL INSTALLATIONS FOR HIGH ADOPTERS
PANEL A: MASSACHUSETTS



PANEL B: CALIFORNIA

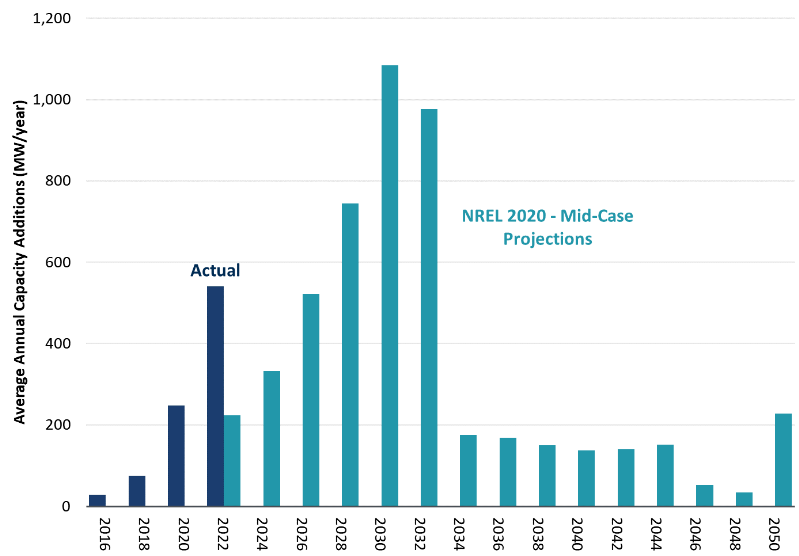


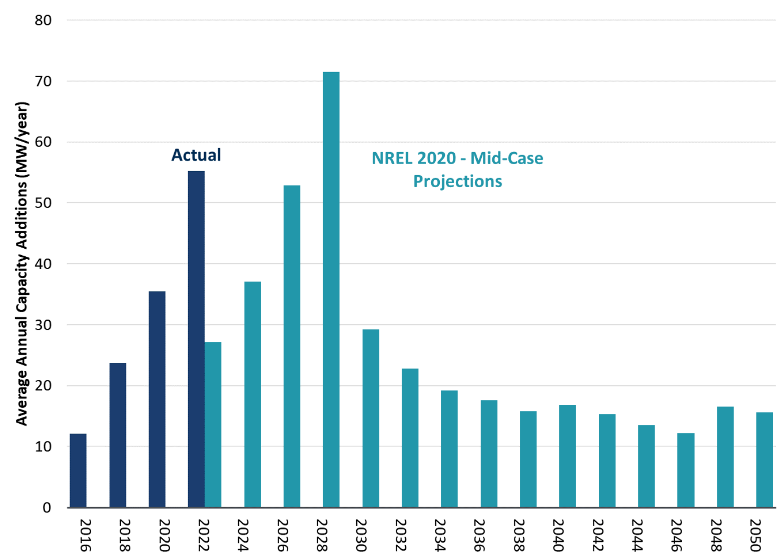
Sources: EIA-861M; NREL 2020 Standard Scenario, Mid-Case.

67. By contrast, the 2020 Mid-Case Scenario projects an increase in distributed solar PV in Florida from just over 1 GW in 2022 to just under 11 GW by 2050, more than a ten-fold increase, corresponding to a compound annual growth rate of 8.6%. Forecasted compound annual growth rates for other poorer southern states with significant sun such as Oklahoma and Mississippi,

which like Florida are likely more appropriate benchmarks than California or Massachusetts, are 19.9% (a 162-fold increase in projected distributed solar capacity between 2022 and 2050) and 16.1% (a 66-fold increase) respectively. Figure 11 (Panels A and B) below shows how, even for states that are better comparison states than California and Massachusetts, such as Florida and New Mexico, where NREL projects larger growth, the NREL 2020 model still under-estimates the pace of annual additions relative to those actually experienced.

FIGURE 11: DISTRIBUTED PV ANNUAL INSTALLATIONS FOR OTHER STATES





Sources: EIA-861M; NREL 2020 Standard Scenario, Mid-Case.

2. Other metrics are relevant for evaluating reasonableness of distributed solar forecasts.

68. Dr. Tierney presents the NREL data on distributed PV generation as a "share of gross load". As I noted earlier, it is not clear why this metric is specifically relevant for assessing the pace of

distributed PV adoption. Further, it is unclear whether the data relied on for that metric are consistent with each other.[43]

69. Furthermore, Dr. Tierney's analysis implies that many US states are expected to reach a maximum share of distributed solar adoption at less than 10% of gross load, suggesting that it is unreasonable for Puerto Rico to expect higher penetration levels of distributed PV. However, the poor track record of the US government and others forecasting the growth of solar PV discussed above and evidence around the world suggests that NREL's Standard Scenario modeling is not a reliable predictor of ultimate distributed solar PV adoption. Distributed solar PV adoption rates already exceed those generally forecast by NREL in several countries and regions. For instance, approximately 23% of Italian households have adopted rooftop solar and over 30% of residential homes in Australia have adopted.[44] In Queensland, the world leader in solar roof adoption, 82% of suitable homes already have solar roofs and 78% do so in South Australia.[45] NREL itself has estimated that close to 90% of all buildings in Puerto Rico and approximately 85% of residential buildings are suitable for rooftop solar[46] so that overall adoption rates could far exceed those projected by NREL's Standard Scenarios and included in Dr. Tierney's Figure 8 if adoption over the coming 30 years is more in line with the experience in other countries with favorable solar conditions than with NREL modeling. As noted above, NREL's Puerto Rico specific modeling work under PR100 projects ultimate penetration rates of 60% or more for residential customers.[47]

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[43] Dr. Tierney relies on NREL data for "Net Electricity and Natural Gas Consumption" for electric load projections, which is based on 2016 estimates and AEO 2019 while the NREL Standard Scenario 2020 she relies on for distributed PV generation is partially based on AEO 2020. It is unclear whether these datasets are consistent with each other.

[44] Power Mag, "A Global Look at Residential Solar Adoption Rates", 29 Jul 2022, https://www.powermag.com/a-global-look-at-residential-solar-adoption-rates/.

[45] Zachary Shahan, "Nearly 1 In 3 Homes In Australia Covered In Solar Panels," Clean Technica, February 28, 2023, https://cleantechnica.com/2023/02/28/nearly-1-in-3-homes-in-australia-covered-in-solar-panels/.

[46] NREL, "Puerto Rico Low-to-Moderate Income Rooftop PV and Solar Savings Potential," December 17, 2020, pages 7 and 19, https://www.nrel.gov/docs/fy21osti/78756.pdf. (1.06 million suitable residential buildings out of 1.24 million total residential buildings.)

[47] NREL, "PR100: One Year Progress Summary Report", January 2023, p. 8, https://www.nrel.gov/docs/fy23osti/85018.pdf.

70. Multiple other metrics are also relevant for understanding the reasonableness of PREPA's distributed PV forecast relative to other jurisdictions or modeling projections. For example, growth rates or absolute cumulatively installed capacity for states of similar size or at similar stages of development with respect to solar PV provide relevant information.

71. As seen in the table below, Puerto Rico has experienced a 30% compound annual growth rate ("CAGR") of distributed PV from 2018 through 2022. Yet by 2022 PREPA had only about 5% customer adoption for rooftop solar (and 6.7% as of 2023[48]), which means there is still a large portion of customers eligible to adopt distributed solar. The Fiscal Plan projections imply a 12% CAGR of distributed PV through 2030 and a 6% CAGR through 2050. This suggests that the CAGR of PV adoption in Puerto Rico may be conservatively projected in the Fiscal Plan.

FIGURE 12: COMPOUND ANNUAL GROWTH RATES FOR PUERTO RICO

	Historical			Fiscal Plan 2022 CAGR	
	Historical (2018-2022)	2022 Capacity (MW)	2022 Customer Adoption (%)	Near-Term (2022-2030)	Long-Term (2022-2050)
	[1]	[2]	[3]	[4]	[5]
Puerto Rico	30.0%	375	4.8%	12.1%	6.1%

Sources and Notes:

- [1]: CAGR calculated from PREPA 2022 Fiscal Plan data.
- [2]: PREPA 2022 Fiscal Plan data.
- [3]: [2] x 1,000 / (5.6 kW/system x 1.4 million total customers).
- [4]-[5]: CAGR calculated from PREPA 2022 Fiscal Plan data.

72. Independent of the issue of NREL's forecasting methodology incorrectly assuming that in states like California or Massachusetts most adoption of distributed solar PV has already occurred – and hence terminal penetration rates will remain relatively low in spite of the evidence in other (international) markets discussed above, Dr. Tierney uses mostly an inappropriate comparison group. Distributed solar generation adoption per customer in Puerto Rico is significantly below

[48] 524 MW x 1,000 / (5.6 kW/system x 1.4 million total customers).

the customer penetration rates of high adopter states such as Hawaii, California, or Massachusetts. As a result, it is reasonable to assume that Puerto Rico still has some "catching up" to do before it would converge to the CAGR of high solar adopter states. Therefore, states like New Mexico or Florida are likely more appropriate comparison states, as can be seen from the table below. Note the general (inverse) relationship in the NREL projected growth rates and existing customer adoption. According to NREL's modeling, states with already high adoption have little growth potential remaining, *i.e.*, they are further along the adoption diffusion curve relative to those states with less existing adoption and more growth potential. Similarly, note the increase in CAGRs between the NREL 2020 projections and the NREL 2022 projections.

FIGURE 13: COMPOUND ANNUAL GROWTH RATES

	Historical			NREL 2020 CAGR		NREL 2022 CAGR	
	CAGR (2018-2022)	2022 Capacity (MW)	2022 Customer Adoption (%)	Near-Term (2022-2030)	Long-Term (2022-2050)	Near-Term (2022-2030)	Long-Term (2022-2050)
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
High Adopters							
Hawaii	6.3%	780	22.0%	n/a	n/a	n/a	n/a
California	15.9%	14,208	12.9%	2.9%	2.4%	7.6%	3.4%
Massachusetts	6.3%	2,003	8.6%	1.2%	1.1%	4.4%	1.9%
Arizona	13.9%	2,104	9.0%	5.2%	3.0%	8.3%	3.6%
New Jersey	13.0%	2,359	8.0%	4.9%	2.1%	8.1%	2.7%
Nevada	26.6%	773	7.7%	8.4%	4.2%	10.9%	4.6%
Other States for Comparison							
New Mexico	23.6%	317	4.3%	12.5%	5.0%	17.4%	6.2%
Florida	60.2%	1,858	2.3%	25.1%	8.6%	30.6%	9.6%
Texas	46.2%	2,170	2.2%	22.9%	9.0%	31.1%	10.7%
Oklahoma	73.1%	65	0.4%	40.8%	16.1%	45.4%	17.1%
Mississippi	21.8%	15	0.1%	47.5%	19.9%	53.5%	20.0%

Sources and Notes:

– [1]: CAGR calculated from EIA-861M data.
– [2]: EIA-861M data, see table Small-Scale PV by State and Year according to EIA.
– [3]: [2] x 1,000 / (7.0 kW/system x Customers from EIA-861M).
– [4]-[5]: CAGR calculated from NREL 2020 Standard Scenario Mid-Case data.
– [6]-[7]: CAGR calculated from NREL 2022 Standard Scenario Mid-Case data.

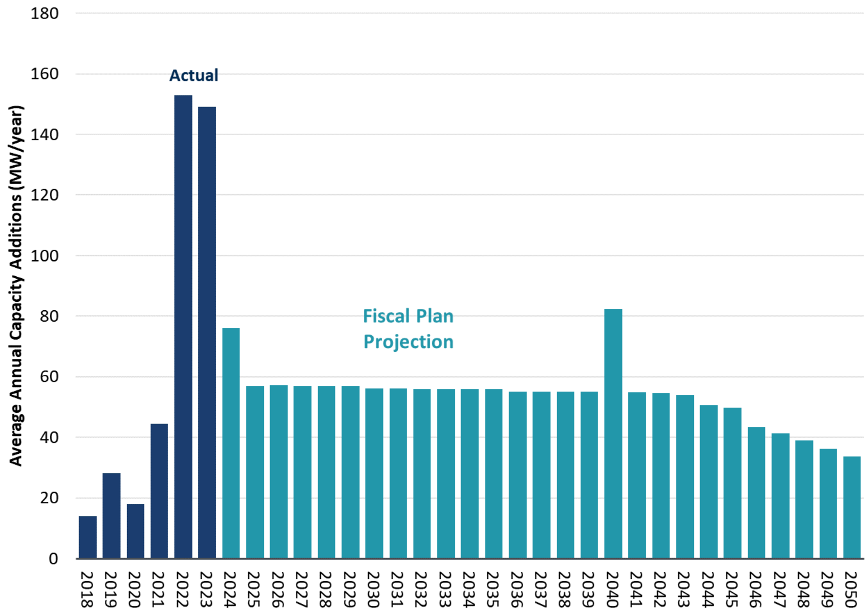
3. Puerto Rico data suggests that PREPA Fiscal Plan projections are not too high and are conservative.

73. One of the most important factors not considered by Dr. Tierney is the speed of actual adoption of distributed solar PV. LUMA collects and reports information about installed solar PV systems (connected under LUMA's net metering program) and reports those regularly to PREB. The most recent filings with PREB show a sharp increase in distributed solar PV systems connected under PREPA's net metering tariff. Based on these regulatory filings, PREPA has added 150 MW per year of new distributed solar PV capacity under the net metering programs in each of the past two years (and over 50,000 systems between June 2021 and March 2023).[49] In comparison, PREPA's fiscal plan, criticized by Dr. Tierney as overly optimistic, assumes less than 60 MW/year of DG solar going forward.

74. Figure 14 below shows the evolution of solar PV installations over the past several years along with the 2022 Fiscal Plan forecast. The Fiscal Plan assumes a more conservative amount of annual adoption than recently experienced. If Puerto Rico were to maintain the 150 MW per year pace, then it would achieve its 2050 plan projection by 2032, *i.e.*, within 10 years rather than 27 years.

[49] *See*, PREB Report from April 20, 2023, docket number NEPR-MI-2019-0007, https://energia.pr.gov/numero_orden/nepr-mi-2019-0007/, "FY23 Performance Metrics by Area- Renewable and DSM-Active (2)". Since PREPA only reports systems connected under the net metering tariff, actual installations could be higher since not all customers may choose to connect under the net metering tariff.

FIGURE 14: PREPA DISTRIBUTED SOLAR ANNUAL INSTALLATIONS



Source: PREPA 2022 Fiscal Plan; PREB Report from April 2023.

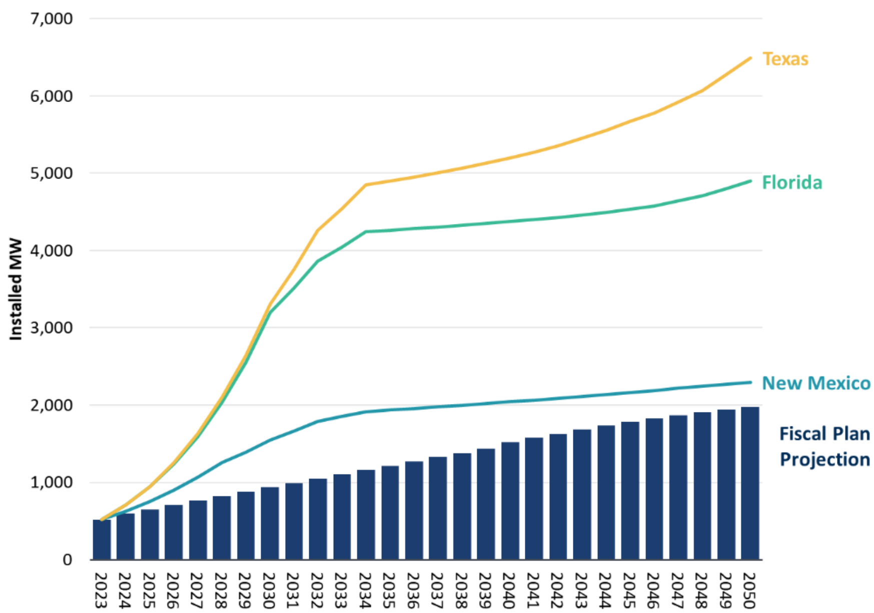
75. As indicated in Figure 13 above, "high adopter" states had significantly more customer adoption than Puerto Rico as of 2022. Assuming an average system size of 7 kW across all customers[50], EIA data suggests that 13% of Californian customers had adopted by 2022 and 22% of Hawaiians. Based on PREPA's Fiscal Plan[51], it would take until 2032 for PREPA to match California's 2022 solar penetration and until 2044 to match Hawaii's 2022 penetration. PREPA's 2022 Fiscal Plan does not assume a 2050 penetration rate of 30% (*already achieved* in other jurisdictions) by 2050, let alone the much higher penetration rates already achieved in Queensland or South Australia. The Fiscal Plan's projections for PV adoption are therefore conservative and will probably be outpaced by 2050.

50 LBL, "Tracking the Sun, 2022 Edition", September 2022, https://emp.lbl.gov/sites/default/files/3_tracking_the_sun_2022_summary_brief.pdf.

51 Also assumes 1.4 million customers and an average system size of 5.6 kW based on recent installation data from PREB Report from April 20, 2023, docket number NEPR-MI-2019-0007, https://energia.pr.gov/numero_orden/nepr-mi-2019-0007/, "FY23 Performance Metrics by Area- Renewable and DSM-Active (2)".

76. Consider what the distributed solar capacity may be if Puerto Rico grew at the same rates as certain other states in the NREL projections (with the caveats regarding the potential under-forecasting of ultimate adoption rates).[52] Figure 8 below indicates the installed distributed solar capacity for Puerto Rico in the Fiscal Plan (blue bars) compared with the capacity implied if Puerto Rico's distributed solar capacity grew from 2023 levels at rates like New Mexico, Florida, or Texas. As demonstrated, these alternative growth rates indicate a range of 300 MW to 4,500 MW additional installed capacity by 2050 relative to the 2022 Fiscal Plan.[53]

FIGURE 15: PUERTO RICO DISTRIBUTED PV, WITH GROWTH SIMILAR TO OTHER NREL STATE PROJECTIONS



Source: PREPA Fiscal Plan; NREL 2022 Standard Scenario Mid-Case.

77. Given all the potential problems with the Mid-Case Scenario forecast discussed above, it is also appropriate to consider the underlying projections of cost. The NREL projections rely on the Annual Technology Baseline ("ATB"). The ATB is a more fundamental view of how costs for

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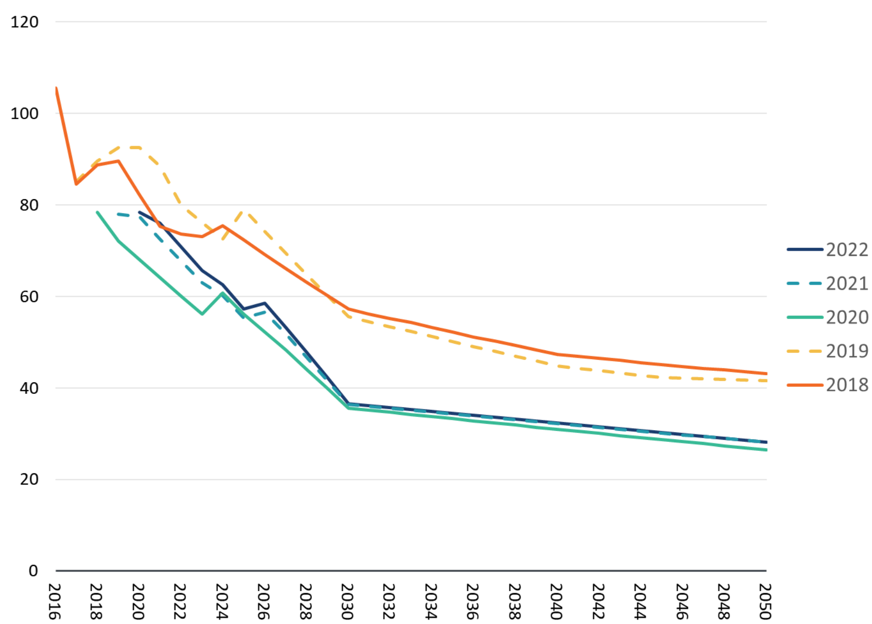
52 For this purpose, I rely on the NREL 2022 Standard Scenario, Mid-Case.

53 NREL's "Puerto Rico Low-to-Moderate Income Rooftop PV and Solar Savings Potential" report (dated December 17, 2020), p. 7, identified almost 10 GW of rooftop solar capacity potential for LMI buildings and over 20 GW of total residential solar potential. The report noted that "solar generation can technically meet all Puerto Rico electrical consumption for all income groups."

various technologies may change over time and less prone to forecast error since the ATB doesn't rely on optimization models to forecast penetration. Figure 16 below shows the decline in the levelized cost of energy ("LCOE") for distributed residential solar PV projected by the ATB for years 2018 through 2022.

FIGURE 16: RESIDENTIAL PV LCOE



Source: ATB 2018-2022, Moderate Scenario. Years 2018-2020 assume Los Angeles location. Years 2021-2022 assume Class 1 solar.

78. As Figure 16 shows, the projected costs of distributed solar PV have been declining in consecutive ATB projections, highlighting the possibility that here too projections tend to underestimate the attractiveness of distributed solar PV in general. I also note that between today and 2030-2050, the cost of distributed solar PV is projected to decline between 50% and about two thirds, in line with past cost declines, and resulting in a projected cost (assuming no further downward revisions in future forecasts) of distributed solar PV dipping below $30/MWh. Given that current and projected retail rates for electricity remain above $200/MWh (in 2021 dollars)[54]

[54] PREPA 2022 Certified Fiscal Plan, p. 140.

before considering any legacy debt payments, distributed solar PV will continue to become more attractive substitute for purchasing power from the grid.[55]

4. Distributed solar PV could well exceed Fiscal Plan projections and make up any shortfall on reaching energy efficiency targets.

79. Dr. Tierney criticizes the reduction in gross load due to energy efficiency measures included in PREPA's 2022 Fiscal Plan and in compliance with the targets under Act 17. Dr. Tierney argues that the energy efficiency measures included in PREPA's Alternative Forecast, which projects 1,577 GWh less energy efficiency savings by 2050 than the base forecast, are more realistic.[56] Given a distributed solar PV capacity factor of 20% (as assumed in the 2022 Fiscal Plan),[57] this 1,577 GWh of load reduction would equate to approximately 900 MW of additional distributed PV capacity by 2050, or an average additional 30 MW per year, equivalent to an additional 5,350 customers per year adopting rooftop solar.[58] As shown in Figure 17 and Figure 18 below, this additional amount of adoption on top of PREPA's existing distributed solar projections (labeled as "Incremental Distributed PV" in below charts) would still require substantially less annual additions of distributed solar PV systems than the annual distributed solar growth experienced in the recent past. As shown in Figure 18, the needed additional distributed solar PV growth would be slightly higher than NREL's currently projected growth for New Mexico, but still far below the projected growth rates for other comparable states like Florida or Texas and at the very low end of NREL's own most recent projections under PR100.

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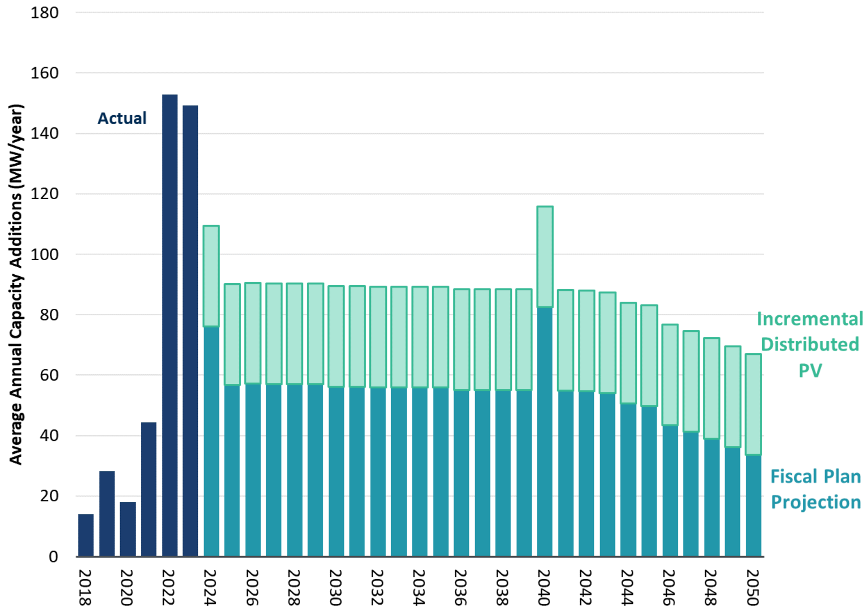
[55] In addition, the use of rooftop solar PV paired with battery storage offers customers an alternative that can improve reliability of their power service relative to the grid (based on PREPA's historically poor SAIDI and SAIFI metrics, for example).

[56] Tierney Report, ¶¶ 49-50 and Figure 6.

[57] 2022 PREPA Fiscal Plan excel model.

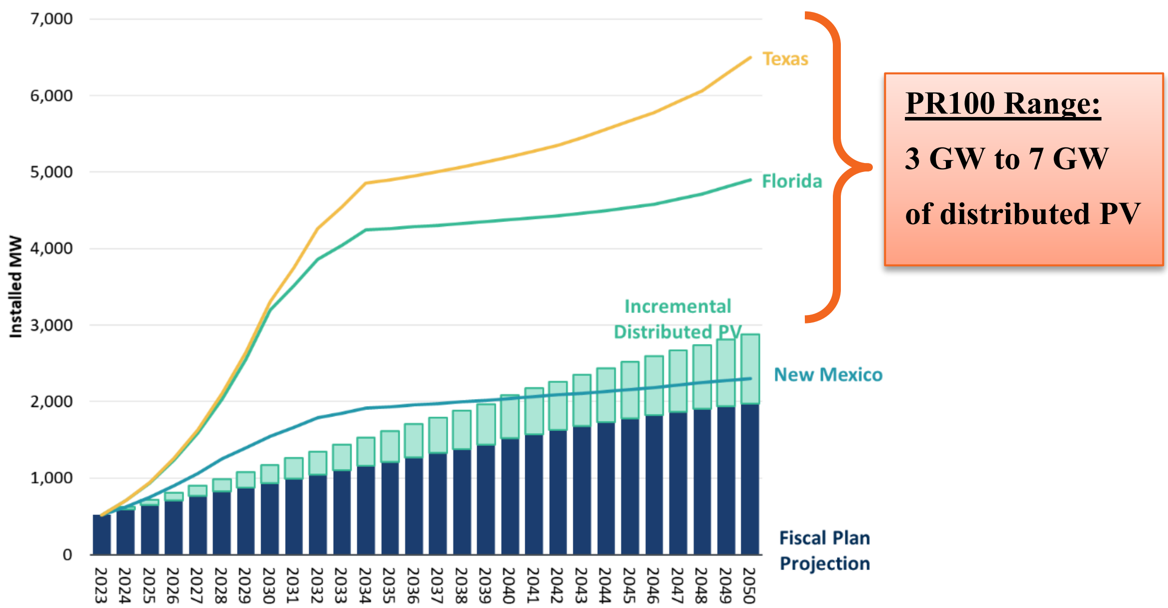
[58] Assumes a 5.6 kW system based on the average of recent installation data implied by PREB Report from April 20, 2023, docket number NEPR-MI-2019-0007, https://energia.pr.gov/numero_orden/nepr-mi-2019-0007/.

FIGURE 17: PREPA DISTRIBUTED PV ANNUAL INSTALLATIONS, WITH ENOUGH INCREMENTAL INSTALLATIONS FOR AN ADDITIONAL 900 MW BY 2050



Source: PREPA Fiscal Plan; PREB report, and Brattle assumptions.

FIGURE 18: PREPA TOTAL DISTRIBUTED PV, WITH ENOUGH INCREMENTAL INSTALLATIONS FOR AN ADDITIONAL 900 MW BY 2050



Source: PREPA Fiscal Plan; PREB report; NREL 2022 Standard Scenario Mid-Case, and Brattle assumptions.

80. Dr. Tierney raises concerns about the affordability of rooftop PV systems for Puerto Ricans and alleges that financing options for residential customers "remain limited."[59] I find Dr. Tierney's concerns about limited financing options to be unconvincing. First, I note that the solar financing report cited by Dr. Tierney is outdated, especially when it refers to only 20,000 solar installations as of April 2020 (of which there may be another 20,000 not registered for Net Energy Metring ("NEM")) and questions the "anemic adoption" in Puerto Rico.[60] Solar installations have quadrupled since that report, and the state of solar financing has changed as well. A more recent (October 2022) article from E&E News refers to a "boom in solar finance" in Puerto Rico since Hurricane Maria in 2017.[61] The article also mentions that the "great majority" of recent solar installations "have been financed by long-term agreements."[62] In addition, new business models and policies will likely mitigate solar system affordability issues. For example, the Investment Tax Credit ("ITC") is already available to US companies operating on the Island, such as to provide distributed solar PV through third-party financing or via Power Purchasing Agreements ("PPA"). The IRA of 2022 also potentially creates opportunities to benefit from the ITC via its direct pay program[63] or via loan guarantees to support the financing of solar systems for lower income households including those in Puerto Rico.[64]

81. Additionally, Dr. Tierney's report was silent on Puerto Rico's commitments to meeting 100% of its energy needs with renewable energy by 2050.[65] As mentioned above, Puerto Rico has been working with multiple government organizations as part of the PR100 study to best meet these

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59 Tierney Report at ¶58.

60 The Solar Foundation, "Finance Report: An Assessment of Opportunities and Barriers to Solar Finance in Puerto Rico," April 2021, p. 13, https://irecusa.org/wp-content/uploads/2021/07/FinanceReport-Completed_5-13.pdf.

61 E&E News, "Meet Puerto Rico's unlikely climate champions: Credit unions", 11 Oct 2022, https://www.eenews.net/articles/meet-puerto-ricos-unlikely-climate-champions-credit-unions/.

62 *Id.* Dr. Tierney's Solar Foundation source notes that 75% of all solar projects in Puerto Rico had been financed via power purchase agreements (p. 32).

63 Elise Vahle, "How the Solar ITC Direct Pay Program Benefits Tax Exempt Organizations," Energylink, November 3, 2022, https://goenergylink.com/blog/direct-pay-program-tax-exempt-orgs/

64 Wall Street Journal, "Energy Department Commits $3 Billion to Expand Rooftop Solar Access", April 20, 2023.

65 Department of Energy, Grid Deployment Office, "Puerto Rico Grid Resilience and Transitions to 100% Renewable Energy Study (PR100)", https://www.energy.gov/gdo/puerto-rico-grid-resilience-and-transitions-100-renewable-energy-study-pr100

goals.[66] Under this effort, distributed PV adoption has been of significant focus. NREL noted in its One Year Progress Summary Report for PR100 that recent modeling results indicate between 3 GW to 7 GW of distributed PV installed by 2050 depending on the scenario.[67] This range is well-above the approximately 2 GW distributed PV capacity conservatively assumed under the 2022 Fiscal Plan.

82. In summary, even though Dr. Tierney ultimately relies on the distributed PV forecast from the Alternative Fiscal Plan, which has a different growth path but reaches substantially the same 2050 projection as the base Fiscal Plan,[68] the reasoning and support for her conclusion that the distributed PV forecasts in both the base and alternative load forecast in PREPA's 2022 Fiscal Plan overestimate PV adoption are largely flawed. As discussed above, correcting for the bias that results from using outdated forecasts and relying on forecasts from entities that have concluded themselves that their forecasts appear to be biased, plus ignoring Puerto Rico specific actual and projected PV installations, suggests that distributed PV is more likely to exceed the Fiscal Plan's conservative projections and could easily do so in ways that would more than mitigate for any hypothetical shortfall of energy efficiency efforts under Act 17.

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66 *See also* PREB orders to Luma and PREPA for implementation of Act-17. On February 16, 2023, PREB issued a Resolution and Order (Case No. NEPR-MI-2022-0001) approving a modified Transition Period Plan. The approved Transition Period Plan was further modified addressing LUMA's motion for reconsideration through a Resolution and Order of April 3, 2023.

67 NREL, "PR100: One Year Progress Summary Report", January 2023, p. 4, https://www.nrel.gov/docs/fy23osti/85018.pdf.

68 Tierney Report at ¶70 ("Forecasts for the energy efficiency, **distributed generation**, and electric vehicle load modifiers from the Base Case are replaced with PREPA's Alternative Forecast projections from the 2022 PREPA Fiscal Plan…")(**emphasis added**).

B. THE CONSTRAINTS ON DISTRIBUTED SOLAR DEVELOPMENT MENTIONED DR. TIERNEY ALREADY EXIST, MAY BE OVERCOME, OR CONTRADICT HER CLAIM RELATED TO CAPITAL EXPENDITURES IN THE FISCAL PLAN BEING MORE THAN SUFFICIENT.

83. Dr. Tierney correctly points out that actual growth of distributed generation (including distributed solar PV) must consider factors other than pure economics.[69]

84. However, the barriers she lists exist today and the rapid growth in distributed solar PV currently observed takes place with those barriers in place. To the extent distributed solar PV becomes more attractive relative to other alternatives, including grid-supplied electricity, the economic motivation to address and overcome any barriers also grows. It is therefore not my opinion that barriers to continued growth in distributed solar generation will necessarily grow over time. Examples of how such barriers might be addressed include the Department of Energy loan guarantee program with Sunnova or the ability in the IRA to benefit from the ITC without filing a US Income Tax return.

85. Dr. Tierney makes one argument about an implementation barrier that contradicts her own claims about the adequacy of capital expenditures forecast in the Fiscal Plan and POA. She claims that growth in distributed solar PV will be hindered by the inability of the Puerto Rico grid to integrate distributed solar PV.[70]

86. It is indeed plausible that a large increase in the installation of distributed PV (and other) resources on Puerto Rico will require the distribution grid to be upgraded. Dr. Tierney cites to various reports to that effect.[71] I am aware of one Puerto Rico distributed generation integration study that has estimated the cost of distribution system mitigation corresponding with 25%, 50%

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69 Tierney Report at ¶¶59-60.

70 *Id.* at ¶60 ("…the kind of substantial, increased deployment of distributed generation modeled by PREPA's forecasts would likely require PREPA to make significant investments in its grid infrastructure to accommodate the injection of such decentralized power supply on a reliable basis.").

71 Tierney Report, footnote 58

and 75% penetration of distributed energy resources to be between $533 million and $652 million.[72]

87. Hence, as Dr. Tierney implies, such costs could be significant. But any conclusion that the growth of distributed solar PV on Puerto Rico will be limited by PREPA's inability to make the necessary distribution (or transmission) system upgrades to integrate additional distributed solar PV into the grid would be at odds with Dr. Tierney's conclusion that PREPA's 2022 Fiscal Plan already overestimates the capital expenditures needed to reliably operate the Puerto Rico electric system over the 28 years covered by the Fiscal Plan.[73] In other words, the need for additional investments into the electric grid cannot be a limiting factor if, as Dr. Tierney concludes, PREPA has already planned for capital expenditures more than sufficient to reliably run PREPA's grid in the future. Alternatively, if Dr. Tierney concluded that PREPA does *not* have enough resources to make necessary grid upgrades to integrate distributed solar PV, Dr. Tierney's conclusions about the adequacy of capital expenditures would be incorrect.

88. Dr. Tierney also mischaracterizes how the increasing attractiveness of distributed solar generation might play out in the unreliable, high-priced Puerto Rico electric system. While she concludes that making necessary investments into the grid would be costly or that "*PREPA does not yet have deep expertise integrating high-penetration levels of distributed generation into its system*"[74], her conclusion that this would limit the growth of distributed solar system installations is debatable. It is also possible that customers will continue to ramp up their solar installations and that the pace of installations will impact the system and reliability of the grid in ways that reinforce the incentives to install distributed systems.

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72 Energy Futures Group, Puerto Rico Distributed Energy Resource Integration Study – Load, Energy Efficiency, and System Cost, February 2021, Table 10.

73 Tierney Report at ¶101.

74 *Id.* at ¶60.

/s/ Jurgen Weiss

Jurgen Weiss, Ph.D.

May 15, 2023

Appendix 1

Resume

JÜRGEN WEISS

Phone : +1.617.792.9055 ♦ Email : jweiss@dash2zero.com

Dr. Jürgen Weiss is an energy economist with almost 30 years of professional experience. He is the founder of Dash2Zero, a decarbonization accelerator and an Academic Advisor at Th Brattle Group. His most recent roles as Visiting Scholar at the IMF and Senior Lecturer at the Harvard Business School follow a 25-year professional career as an energy and industrial organizations consultant. His work focuses on renewable energy, climate change and electric utility economics with particular emphasis on transition strategies towards low carbon energy systems. He was previously a Senior Fellow at the Harvard Electricity Policy Group (HEPG), a Faculty Fellow of the Harvard Environmental Economic Program (HEEP) and a Faculty Fellow at the Harvard University Center for the Environment (HUCE) and has served on several advisory councils such as for California's Low Carbon Fuel Standard, the King Abdullah City of Atomic and Renewable Energy in Saudi Arabia and the Department of Energy's Wind Vision Task Force.

PROFESSIONAL EXPERIENCE

2022-present	Founder, *Dash2Zero*	*Somerville, MA (USA)*
2022-present	Visiting Scholar and Short-term Expert, *IMF*	*Washington, DC (USA)*
2020-2022	Senior Lecturer, *Harvard Business School*	*Boston, MA (USA)*
2020-present	Academic Advisor, *The Brattle Group, Inc.*	*Boston, MA (USA)*
2009-2020	Principal, *The Brattle Group, Inc.*	*Cambridge, MA (USA)*
2008-09	Managing Director, *Point Carbon, Inc.*	*Boston, MA (USA)*
2007-09	Founding Director, *Watermark Economics, LLC.*	*Boston, MA (USA)*
2004-07	Director, *LECG, Inc.*	*Cambridge, MA (USA)*
1999-2004	Independent Economic Consultant.	*Somerville, MA (USA)*
1998-1999	Associate, *The Brattle Group, Inc.*	*Cambridge, MA (USA)*
1994-1995	Associate, Booz Allen & Hamilton, Inc.	*New York, NY (USA)*

EDUCATION

1993-98 *Harvard University* Cambridge, MA (USA)
Ph.D. Business Economics

1991-93 *Columbia University* New York, NY (USA)
Master of Business Administration

1987-91 *European Partnership of Business Schools* Reutlingen (D) and Reims (F)
B.A. European Business Administration

TEACHING EXPERIENCE

2022 *International Monetary Fund* Washington, DC
Visiting Scholar and Short-term Expert
Co-developed and taught climate change macroeconomics course for IMF's *Institute for Capacity Development* and co-taught course in Singapore and Kuwait (2022)

2020-2022 *Harvard Business School* Boston, MA
Senior Lecturer in the Business Government and International Economy Unit
Business, Government and the International Economy (Spring 2021)
Global Energy in Transition (Fall 2021)

2005 *EPBS University of Reutlingen* Reutlingen (D)
Business Strategy

1995-97 *Harvard University* Cambridge, MA
EC 10

SELECT ENERGY TRANSITION AND CLIMATE CONSULTING WORK

- For Rhode Island's Office of Energy Resources, Dr. Weiss assisted in the development of an action plan to meet the Governor's executive order for a 100% renewable electricity to supply for Rhode Island by 2030. ("The Road to 100% Renewable Electricity by 2030 in Rhode Island", The Brattle Group, December 2020)
- For the NYISO, Dr. Weiss was part of a Brattle team to analyze potential paths (and their implications) to meet New York's requirement for a 100% clean electricity grid by 2040. (New York's Evolution to a Zero Emission Power System, The Brattle Group, June 22, 2020)

- For a state agency, Dr. Weiss was part of a Brattle team to assess the potential role of Canadian hydro (and other clean energy) resources to contribute to a clean electric system in the Northeastern United States. (non-public, 2019)
- For Rhode Island's Division of Public Utilities & Carriers, Dr. Weiss assisted in the development of a heating sector transformation study to assess pathways and action plans to decarbonize the State's heating sector by 2050. ("Heating Sector Transformation in Rhode Island: Pathways to Decarbonization by 2050, The Brattle Group, April 2020)
- For the Coalition for Community Solar Access, Dr. Weiss lead a Brattle team conducting a study on the requirements to meet clean energy resource deployment in New England consistent with economy-wide decarbonization targets in the region. ("Achieving 80% GHG Reduction in New England by 2050: Why the region needs to keep its food on the clean energy accelerator, Jürgen Weiss and J. Michael Hagerty, September 2019.)
- For WIRES, a trade group focusing on transmission infrastructure in the United States, Dr. Weiss lead a study to identify additional transmission needs in a decarbonized US grid. ("The Coming Electrification of the North American Economy: Why we need a robust transmission grid", Jürgen Weiss and J. Michael Hagerty, March 2019.)
- For EPRI, Dr. Weiss was part of a Brattle team including Nobel Prize Laureate and Brattle Principal Prof. Dan McFadden that developed a discrete choice-based electric vehicle adoption model. (2019)
- For Friends of the Earth, Dr. Weiss led a team developing options for the City of Memphis to decarbonize post a hypothetical exit from the TVA system. ("Power to Memphis: Options for a reliable, affordable and greener future", Jürgen Weiss, Judy Chang, Nicholas Powers, and Kai Van Horn, March 2019)
- For the New Hampshire Attorney General's Office, Dr. Weiss was serving as an expert witness evaluating the energy, capacity, and environmental benefits of the Northern Pass transmission project, a proposed HVDC transmission line linking the Canadian Province of Quebec with the New England power system. (2017-18)
- For the New York Independent System Operator (NYISO), Dr. Weiss is part of a Brattle team developing a proposal to use an ISO-based carbon price as a tool to reach 2030 State decarbonization goals. (2017)
- For the Office of Energy Resources of the State of Rhode Island, Dr. Weiss and his colleague Dr. Berkman performed an economic and environmental impact analysis of the State's Renewable Energy Growth (REG) Program. (2017)
- For a coalition of municipal utilities, Dr. Weiss assessed the Scoping Plan Update proposed by the California Air Resources Board (CARB) to meet the greenhouse gas reduction targets under Senate Bill 350 (SB350) for the purposes of allowing the coalition to make comments to CARB. (2017)

- For a power cooperative in Kentucky, Dr. Weiss and Brattle colleague Jamie Read helped develop a voluntary retail tariff that allows coop members to participate in a shared community scale solar PV facility selling output into wholesale markets. Tariff was approved by the Kentucky Public Utility Commission. (2016)
- For Hawaiian Electric, Dr. Weiss was part of a Brattle team heling HECO's prepare a proposed integrated resource plan for the Hawaiian Public Utilities Commission to meet with required full decarbonization goal by 2045. (2016)
- For the Singapore Electricity Market Authority, Dr. Weiss led a Brattle team to explore the impact of increasing levels of solar PV penetration on the ancillary service requirements of the Singapore Market, resulting in a set of recommendations concerning options for charging for such incremental reserves once solar PV penetration reaches certain levels. (2016)
- For the Advanced Energy Economy Institute, Dr. Weiss led a Brattle effort to investigate best practices in the integration of renewable energy through two cases studies of U.S. systems with relatively high shares of renewable energy, namely Xcel Colorado on ERCOT. (2015)
- Dr. Weiss assisted the Australian Energy Market Commission in developing options for the development of a Safeguard Mechanism to assure that greenhouse gas emissions from existing power plants will not exceed baseline emissions in the future. (2015)
- For the Advanced Energy Economy Institute, Dr. Weiss led a team of Brattle experts to assess the North American Electric Reliability Corporation's (NERC) initial reliability assessment of the U.S. Environmental Protection Agency's Clean Power Plan, which is designed to lower greenhouse gas emissions from existing power plants. The project involved assessing NERC's review and providing a range of options for providing reliability while complying with the Clean Power Plan. (2015)
- For the Solar Energy Industry Association, Dr. Weiss authored a report examining the experience with Germany's solar PV support programs in detail. The report evaluated the impact of Germany's system of feed-in tariffs (FITs) on the cost of solar, retail rates, macroeconomic competitiveness, greenhouse gas emissions and system reliability, with an eye towards lessons that can be learned from the German experience. (2014)
- For the Office of Energy Resources of the State of Rhode Island, Dr. Weiss and his colleague Dr. Berkman performed an economic and environmental impact analysis of the State' distributed energy and renewable energy fund programs. (2013-2014)
- For the European Bank for Reconstruction and Development (EBRD) and as part of a team led by the law firm Pierce Atwood LLP, Dr. Weiss was responsible for developing an economic and environmental impact assessment of a large number of proposed changes to the laws of Kazakhstan in the areas of water, waste and energy/air emissions designed to move the country toward a Green Economy. (2013-2014)

- On behalf of Great River Energy, a large mid-western generation and transmission utility, Dr. Weiss developed a proposal to use an ISO-based carbon pricing mechanism as a way to comply with Section 111(d) of the United States Clean Air Act ("Existing Source Rule") (2013-2014)
- On behalf of a group of not-for-profit organizations including the Center for American Progress, the Sierra Club, the Clean Energy States Alliance and the US Offshore Wind Collaborative, Dr. Weiss lead a study on the economic impact of scaling offshore wind energy to the point where it might reach grid parity with conventional sources of electricity (2013).
- Dr. Weiss co-authored a report for the Bipartisan Policy Center analyzing the domestic and international experience with various forms or renewable energy support, drawing lessons about key elements of a successful U.S. renewable support policy (2012).
- Dr. Weiss led a Brattle team on two reports for the Solar Energy Industry Association analyzing the hypothetical impact of additional amounts of PV capacity on wholesale prices, customer payments and greenhouse gas emissions in Texas and New York respectively (2012).
- For a major California electric utility, Dr. Weiss helped develop an experimental simulation design to test the market rules of the proposed greenhouse gas cap and trade market scheduled to begin operations in the fall of 2012 (2012).
- Dr. Weiss evaluated several renewable power long-term power purchasing agreements for the MA Office of the Attorney General and served as an expert witness in related regulatory proceedings before the Massachusetts Department of Public Utilities (2010/2011/2013).
- On behalf of the Massachusetts Attorney General Dr. Weiss served as an expert witness in the Cape Wind proceeding, in which approval of a 15-year power purchasing agreement for the output from the 468MW offshore wind project was sought. The analysis focused on a comparison of the terms of the proposed PPA to the costs of comparable offshore wind projects and contracts in the United States and Europe (2010).

U.S. TESTIFYING EXPERIENCE

Direct Prefiled Testimony in re: The Narragansett Electric Company d/b/a National Grid Review of Power Purchase Agreement on behalf of DWW REV I, LLC before the State of Rhode Island and Providence Plantations Public Utilitites Commission in Docket No. 4929. (April 5, 2019).

Direct Prefiled Testimony and Report entitled "Electricity Market Impacts of the Proposed Northern Pass Transmission Project: Supplemental Report", submitted by Dr. Samuel Newell and Dr. Jurgen Weiss, prepared for The New Hampshire Counsel for the Public and filed in front

of the New Hampshire Site Evaluation Committee in Docket No. 2015-06. (April 17, 2017).

Direct Prefiled Testimony and Report entitled „Electricity Market Impacts of the Proposed Northern Pass Transmission Project", submitted by Dr. Samuel Newell and Dr. Jurgen Weiss, prepared for The New Hampshire Counsel for the Public and filed in front of the New Hampshire Site Evaluation Committee in Docket No. 2015-06. (February 10, 2017).

Direct Prefiled Testimony and Exhibits of Judy W. Chang and Jurgen Weiss, Ph.D. in Response to Fitchburg Gas and Electric Company's Petition for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance with the requirements of Section 83A of the Massachusetts Green Communities Act and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 13-57, in front of the Massachusetts Department of Public Utilities, Docket No. D.P.U. 13-146 (November 2013).

Direct Prefiled Testimony and Exhibits of Judy W. Chang and Jurgen Weiss, Ph.D. in Response to Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid's Petition for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance with the requirements of Section 83A of the Massachusetts Green Communities Act and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 13-57, in front of the Massachusetts Department of Public Utilities, Docket No. D.P.U. 13-147 (November 2013).

Direct Prefiled Testimony and Exhibits of Judy W. Chang and Jurgen Weiss, Ph.D. in Response to NSTAR Electric Company's Petition for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance with the requirements of Section 83A of the Massachusetts Green Communities Act and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 13-57, in front of the Massachusetts Department of Public Utilities, Docket No. D.P.U. 13-148 (November 2013).

Direct Prefiled Testimony and Exhibits of Judy W. Chang and Jurgen Weiss, Ph.D. in Response to Western Massachusetts Electric Company's Petition for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance with the requirements of Section 83A of the Massachusetts Green Communities Act and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 13-57, in front of the Massachusetts Department of Public Utilities, Docket No. D.P.U. 13-149 (November 2013).

Direct Prefiled Testimony of Judy Chang and Dr. Jurgen Weiss in Response to Fitchburg Gas and Electric Company's Petitions for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance with the requirements of the Act Relative to Green Communities (St. 2008, c. 169, § 83) and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 10-76, in front of the Massachusetts Department of Public Utilities, Docket No. 11-30 (July 2011).

Direct Prefiled Testimony of Judy Chang and Dr. Jurgen Weiss in Response to Western

Massachusetts Electric Company's Petitions for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance with the requirements of the Act Relative to Green Communities (St. 2008, c. 169, § 83) and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 10-76, in front of the Massachusetts Department of Public Utilities, Docket No. 11-12 (June 2011).

Direct Testimony of Judy Chang and Dr. Jurgen Weiss in Response to NSTAR Electric Company's Petitions for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance with the requirements of the Act Relative to Green Communities (St. 2008, c. 169, § 83) and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 10-76, in front of the Massachusetts Department of Public Utilities, Dockets No. 11-05, 11-06 and 11-07 (June 2011).

Direct Prefiled Testimony of Judy Chang and Dr. Jurgen Weiss in Response to NSTAR Electric Company's Petitions for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance with the requirements of the Act Relative to Green Communities (St. 2008, c. 169, § 83) and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 10-76, in front of the Massachusetts Department of Public Utilities, Dockets No. 11-05, 11-06 and 11-07 (May 2011).

Direct Testimony of Dr. Jurgen Weiss and Judy Chang in Response to the Petition of Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid for approval by the Department of Public Utilities of amended power purchase agreements between National Grid and Cape Wind Associates, LLC., in front of the Massachusetts Department of Public Utilities, Docket No. 10-54 (September, 2010).

Direct Prefiled Testimony of Dr. Jurgen Weiss and Judy Chang in Response to the Petition of Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid for approval by the Department of Public Utilities of amended power purchase agreements between National Grid and Cape Wind Associates, LLC., in front of the Massachusetts Department of Public Utilities, Docket No. 10-54 (August 20, 2010).

Deposition of Dr. Jurgen Weiss in MC ASSET RECOVERY, LLC, Plaintiff, v. THE SOUTHERN COMPANY, Defendant, CIVIL ACTION No. 1:06-CV-0417-BBM (February 2008).

Expert Report of Dr. Jurgen Weiss in MC ASSET RECOVERY, LLC, Plaintiff, v. THE SOUTHERN COMPANY, Defendant, CIVIL ACTION No. 1:06-CV-0417-BBM (December 2007).

Deposition in re: Welding Rod Products Liability Litigation, Case No. 1:03-CV-17000 MDL Docket No. 1535 (May 2005).

Deposition in Tractebel Energy Marketing, Inc., Plaintiff, against AEP Power Marketing, Inc.,

American Electric Power Company, Inc., and Ohio Power Company, defendants, 03 CIV.6731(HB)(JCF); and Ohio Power Company and AEP Power Marketing, Inc., Plaintiff, against Tractebel Energy Marketing, Inc. and Tractebel S.A. (now known as Suez-Tractebel S.A.), Defendants. 03 CIV.6770(HB)(JCF) (March 2005).

Preliminary Expert Witness Declaration of Jurgen Weiss, Ph.D. in re: Welding Rod Products Liability Litigation, Case No. 1:03-CV-17000 MDL Docket No. 1535 (February 2005).

Rebuttal Report of Dr. Jurgen Weiss in Tractebel Energy Marketing, Inc., Plaintiff, against AEP Power Marketing, Inc., American Electric Power Company, Inc., and Ohio Power Company, defendants, 03 CIV.6731(HB)(JCF); and Ohio Power Company and AEP Power Marketing, Inc., Plaintiff, against Tractebel Energy Marketing, Inc. and Tractebel S.A. (now known as Suez-Tractebel S.A.), Defendants. 03 CIV.6770(HB)(JCF) (February 2005).

Direct Testimony of Dr. Jurgen Weiss in Petition and tariff filing of Green Mountain Power Corporation re: proposed rate design changes to take effect January 1, 2005, in front of the Vermont Public Service Board, Docket No. 6958 (December 2004).

Prefiled Surrebuttal Testimony of Dr. Jurgen Weiss in Petition and tariff filing of Green Mountain Power Corporation re: proposed rate design changes to take effect January 1, 2005, in front of the Vermont Public Service Board, Docket No. 6958 (November 2004).

Prefiled Testimony of Dr. Jurgen Weiss in Petition and tariff filing of Green Mountain Power Corporation re: proposed rate design changes to take effect January 1, 2005, in front of the Vermont Public Service Board, Docket No. 6958 (August 2004).

Expert Report of Dr. Jurgen Weiss in Keith Lemon and Lori Lemon, Plaintiffs, vs. Daniel P. McNeil and West Lynn Creamery, Defendants, in Superior Court of the Commonwealth of Massachusetts, (August 2004).

Direct Testimony of Dr. Jurgen Weiss in Investigation into General Order No.45 filed by Vermont Yankee Nuclear Power Corporation re: proposed sale of Vermont Yankee Nuclear Power Station and related transactions, in front of the Vermont Public Service Board, Docket No. 6545 (2002).

Prefiled Rebuttal Testimony of Dr. Jurgen Weiss in Investigation into General Order No.45 filed by Vermont Yankee Nuclear Power Corporation re: proposed sale of Vermont Yankee Nuclear Power Station and related transactions, in front of the Vermont Public Service Board, Docket No. 6545 (March 2002).

Prefiled Testimony of Dr. Jurgen Weiss in Investigation into General Order No.45 filed by Vermont Yankee Nuclear Power Corporation re: proposed sale of Vermont Yankee Nuclear Power Station and related transactions, in front of the Vermont Public Service Board, Docket No. 6545 (January 2002).

Prefiled Rebuttal Testimony of Dr. Jurgen Weiss in Investigation into General Order No.45 filed by Vermont Yankee Nuclear Power Corporation re: proposed sale of Vermont Yankee Nuclear Power Station and related transactions, in front of the Vermont Public Service Board, Docket No. 6300 (June 2000).

Direct Testimony of Dr. Jurgen Weiss in Investigation into General Order No.45 filed by Vermont Yankee Nuclear Power Corporation re: proposed sale of Vermont Yankee Nuclear Power Station and related transactions, in front of the Vermont Public Service Board, Docket No. 6300 (May 2000).

Deposition of Dr. Jurgen Weiss in Investigation into General Order No.45 filed by Vermont Yankee Nuclear Power Corporation re: proposed sale of Vermont Yankee Nuclear Power Station and related transactions, in front of the Vermont Public Service Board, Docket No. 6300 (April 2000).

Prefiled Testimony of Dr. Jurgen Weiss in Investigation into General Order No.45 filed by Vermont Yankee Nuclear Power Corporation re: proposed sale of Vermont Yankee Nuclear Power Station and related transactions, in front of the Vermont Public Service Board, Docket No. 6300 (April 2000).

PUBLICATIONS (TEACHING)

"FirstLight Power – Pumped Storage for the (New) Ages." Weiss, Jurgen, HBS Teaching Plan 722-075, June 2022.

"NuScale—Commercializing the First Small Modular Reactor in the World." Weiss, Jurgen, HBS Teaching Plan 722-076, May 2022.

"Woodside—Betting on the Future of Gas." Weiss, Jurgen, HBS Teaching Plan 722-079, May 2022

"1366 Technologies: Surviving in a Fast Changing World." Weiss, Jurgen, HBS Teaching Plan 722-464, May 2022.

"Dandelion: Making Geothermal Heat Pumps a Real Option." Weiss, Jurgen, HBS Teaching Plan 722-074, May 2022.

"Siemens Energy—Positioning an Energy Giant for the Future." Weiss, Jurgen, HBS Teaching Plan 722-078, May 2022.

"Northvolt: Making the World's Greenest Battery." Weiss, Jurgen, HBS Teaching Plan 722-077, March 2022.

"FirstLight Power – Pumped Storage for the (New) Ages." Weiss, Jurgen, Harvard Business School Case 722-029, October 2021.

"Siemens Energy - Positioning an Energy Giant for the Future." Weiss, Jurgen, and Tonia Labruyere. Harvard Business School Case 722-014, October 2021.

"Woodside - Betting on the Future of Gas." Weiss, Jurgen. Harvard Business School Case 722-019, September 2021.

"Oil: History, Present and Future." Weiss, Jurgen. Harvard Business School Background Note 722-011, August 2021.

"Dandelion: Making Geothermal Heat Pumps a Real Option." Weiss, Jurgen. Harvard Business School Case 722-010, August 2021.

"Northvolt: Making the World's Greenest Battery." Weiss, Jurgen, and Emilie Billaud. Harvard Business School Case 722-004, August 2021.

"Daimler - Betting on the Future of Mobility." Weiss, Jurgen. Harvard Business School Case 722-006, July 2021.

"NuScale - Commercializing the First Small Modular Reactor in the World." Weiss, Jurgen, and Richard H.K. Vietor. Harvard Business School Case 721-047, May 2021.

"1366 Technologies: Surviving in a Fast Changing World." Weiss, Jurgen, William A. Sahlman, and Joseph B. Lassiter III. Harvard Business School Case 721-015, October 2020.

SELECTED PUBLICATIONS

"Who's afraid of 100%?" Op-Ed article published in Utility-Dive, February 6, 2020, (https://www.utilitydive.com/news/whos-afraid-of-100/571772/)

"Decarbonizing economy requires lot more electricity", Jürgen Weiss, in *CommonWealth*, October 2019.

"The Electrified Future is Shared", Jürgen Weiss, Public Utilities Fortnightly, PUF 2.0, Mid-February 2018.

"The electrification accelerator: Understanding the implications of autonomous vehicles for electric utilities", Jürgen Weiss, Ryan Hledik, Roger Lueken, Tony Lee, Will Gorman, *The Electricity Journal* 30 (2017) 50–57, December 2017.

"Hurry or Wait – The Pros and Cons of Going Fast or Slow on Climate Change", with Eleanor

Denny, *The Economists Voice*, 2015, 12(1).

"What can (or should) we take away from Germany's renewable experience?" *Electricity Daily*, January 2015.

"What is the role of cap-and-trade schemes in reducing CO2 and other greenhouse gas emissions?" Jurgen Weiss, in *CommentVisions*, February 7, 2013

"Gas Demand Response: Are LDCs and customers ready for dynamic prices?" Ahmad Faruqui and Jurgen Weiss, *Fortnightly's SPARK*, August 25, 2011, http://spark.fortnightly.com.

"What Does Copenhagen Mean for Investments in Low-Carbon Technologies?" Jürgen Weiss, *The Journal of Environmental Investing*, Beyond Copenhagen, Vol 1, No. 1 (2010)

"Carbon as an Investment Opportunity," Jürgen Weiss and Veronique Bugnion, *Environmental Alpha*, Angello Calvello (editor), Wiley Finance, November 2009.

"Estimating the value of electricity storage in PJM: Arbitrage and some welfare effects," Jürgen Weiss, Ramteen Sioshansi, Paul Denholm, and Thomas Jenkin, *Energy Economics*, Vol 31 (2009), pp.269-277.

"Are REC Markets a Wreck Waiting to Happen?" Jürgen Weiss, *Natural Gas & Electricity*, Vol. 23, No. 4, November 2006.

"Market Power and Power Markets," Jürgen Weiss, *Interfaces*, Volume 32, No. 5, September-October 2002, pp (37-46).

"Netzzugang in Deutschland im internationalen Vergleich," Jürgen Weiss, Wolfgang Pfaffenberger, Carlos Lapuerta, Hannes Pfeifenberger, *Energiewirtschaftliche Tagesfragen*, Band 49, Heft 7, 1999, pp (446-451).

LANGUAGES

Dr. Weiss is trilingual in English, German and French and has been active professionally in all three languages.

Appendix 2: Documents Relied Upon

LEGAL DOCUMENTS

- Expert Report of Maureen M. Chakraborty, PHD, dated April 28, 2023.
- Expert Report of Susan Tierney, PHD, dated April 28, 2023.
- PREPA 2022 Certified Fiscal Plan.
- PREB, Resolution and Order, Case No. NEPR-MI-2022-0001, dated February 16, 2023, https://energia.pr.gov/en/dockets/?docket=nepr-mi-2022-0001.

PUBLICATIONS AND BOOKS

- Brown, Marilyn A., et al. "High energy burden and low-income energy affordability: Conclusions from a literature review." Progress in Energy 2.4 (2020): 042003.
- Drehobl, Ariel, Lauren Ross, and Roxana Ayala. "How high are household energy burdens." An Assessment of National and Metropolitan Energy Burdens across the US (2020).

RECEIVED FROM PRODUCTION

- PREPA Fiscal Plan Model v06.29.2022 vSHARE.xlsx.
- Revenue Envelope and Legacy Charge_protected.xlsx
- HIST_PREPA_CUSTOMER_10312020.xlsx
- HIST_PREPA_CUSTOMER_11302020.xlsx
- HIST_PREPA_CUSTOMER_12312020.xlsx
- HIST_PREPA_CUSTOMER_01312021.xlsx
- HIST_PREPA_CUSTOMER_02282021.xlsx
- HIST_PREPA_CUSTOMER_03312021.xlsx
- HIST_PREPA_CUSTOMER_04302021.xlsx
- HIST_PREPA_CUSTOMER_05312021.xlsx
- HIST_PREPA_CUSTOMER_06302021.xlsx
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- NOV 20.xlsx
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- FEB 21.xlsx
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- NEW_HIST_PREPA_CUSTOMER_MAY2022.xlsx
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- NEW_HIST_PREPA_CUSTOMER_AUG2021.xlsx
- NEW_HIST_PREPA_CUSTOMER_DEC2021.xlsx
- NEW_HIST_PREPA_CUSTOMER_FEB2022.xlsx
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- NEW_HIST_PREPA_CUSTOMER_JUN2022.xlsx
- NEW_HIST_PREPA_CUSTOMER_MAR2022.xlsx

PUBLICLY AVAILABLE DOCUMENTS

- NREL, “PR100: One Year Progress Summary Report”, January 2023, https://www.nrel.gov/docs/fy23osti/85018.pdf.
- U.S. Energy Information Administration EIA, (2021) "T5.a Residential average monthly bill by Census Division, and State", available at https://www.eia.gov/electricity/sales_revenue_price/pdf/table5_a.pdf.
- Kollar, J. S. and M. (2022, September 13). Income in the United States: 2021. Census.gov, https://www.census.gov/library/publications/2022/demo/p60-276.html.

- U.S. Bureau of Labor Statistics, Table 1110. Deciles of income before taxes: Shares of annual aggregate expenditures and sources of income, Consumer Expenditure Surveys, 2021, https://www.bls.gov/cex/tables/calendar-year/aggregate-group-share/cu-income-deciles-before-taxes-2021.pdf.
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- EIA, Annual Energy Outlook 2022 Retrospective: Evaluation of Previous Reference Case Projections, September 2022.
- United States Census Bureau, 2020 Census, https://www.census.gov/quickfacts/fact/table/PR/PST045222, accessed May 15, 2023.
- United States Census Bureau, Annual Estimates of the Resident Population for the United States, Regions, States, District of Columbia and Puerto Rico: April 1, 2020 to July 1, 2022 (NST-EST2022-POP), https://www2.census.gov/programs-surveys/popest/tables/2020-2022/state/totals/NST-EST2022-POP.xlsx.
- Guardian News and Media. (2015, July 12). Puerto Rico's soaring cost of living, from giant electric bills to $5 cornflakes. The Guardian. https://www.theguardian.com/world/2015/jul/12/puerto-rico-cost-of-living.
- IPUMS, PRCS Variable Information, https://usa.ipums.org/usa-action/variables/COSTELEC#codes_section.
- tables CE5.3a and CE5.3b at https://www.eia.gov/consumption/residential/data/2015/index.php?view=consumption
- NREL Data Viewer, "Mid-Case Scenario," State and Local Planning for Energy, 2020, https://maps.nrel.gov/slope/data-viewer?layer=standard-scenarios.mid-re-cost&res=state&year=2020&filters=%5B%5D.
- EIA, Annual Energy Outlook 2022 Retrospective: Evaluation of Previous Reference Case Projections, September 2022.
- EIA, Wind and Solar Data and Projections from the U.S. Energy Information Administration: Past Performance and Ongoing Enhancements, March 2016.
- EIA, 2015 RECS Release, tables CE5.3a and CE5.3b, https://www.eia.gov/consumption/residential/data/2015/index.php?view=consumption.
- PV Magazine, "IEA low-balls solar growth (again)", 9 October 2018, https://www.pv-magazine.com/2018/10/09/iea-low-balls-solar-growth-again/.
- SEIA, "Solar Market Insight Report 2022 Year in Review", 9 Mar 2023, https://www.seia.org/research-resources/solar-market-insight-report-2022-year-review.
- NREL Scenario Viewer and Data Downloader, https://scenarioviewer.nrel.gov/.
- National Renewable Energy Laboratory, 2022 Standard Scenarios Report: A U.S. Electricity Sector Outlook, NREL/TP-6A40-84327. https://www.nrel.gov/docs/fy23osti/84327.pdf.

- Department of Energy, Grid Deployment Office, "Puerto Rico Grid Resilience and Transitions to 100% Renewable Energy Study (PR100)", https://www.energy.gov/gdo/puerto-rico-grid-resilience-and-transitions-100-renewable-energy-study-pr100.
- Form EIA-861M, https://www.eia.gov/electricity/data/eia861m/.
- Power Mag, "A Global Look at Residential Solar Adoption Rates", 29 Jul 2022, https://www.powermag.com/a-global-look-at-residential-solar-adoption-rates/.
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